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INSTRUCTIONS TO AUTHORS

Three numbers of the Journal are published every year, in April, August and December respectively and contributions for publication should be sent to the Editor not later than February 1, June 1, and October 1 respectively.

Contributors are requested to be clear and concise. Manuscripts should not exceed 8,000 words and should be in a final form for the press. Each paper should start with a short summary which should be an abstract of the whole paper, complete and clear in itself, and not over 3 per cent. of the length of the paper. The introduction and reviews of literature should be restricted to closely pertinent papers.

The manuscript should be typewritten on one side of the paper only, with wide margins and be double spaced throughout including titles, footnotes, literature citations and legends. Symbols, formulae and equations must be written clearly and with great care. Scientific names of genera and species are printed in italics and should be underlined in the typescript. Too many tables, graphs, etc. should be avoided. Each table should be typed on a separate sheet with its proper position marked in the text in pencil.

Literature citations: All references to literature cited in the text should be presented together at the end of the paper in alphabetical order of authors' names. Each reference should be given in a standard form as follows: (1) name(s), followed by initial(s), of author(s); (2) year of publication in brackets; (3) full title of paper; (4) title of journal, abbreviated according to *World List of Scientific Periodicals*, 1952, and underlined; (5) volume number in Arabic numerals, underlined with two lines to indicate bold type; (6) page numbers without the prefix, p. When books are mentioned in the references, the order should be: name of author(s), initial(s), year in brackets, title of the book, which should be underlined, volume number, edition, page, followed by place of publication and name of publisher. Where a reference has not been seen in original, it should be indicated by an asterisk and the name of the abstracting journal or other source should be mentioned in brackets. If the title is in a language other than English, the diacretic signs, etc., should be precisely given as in the original.

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References:

Raman, C. V. (1949) The theory of the Christiansen experiment. *Proc. Indian Acad. Sci.*, A, 29: 381-90.

Sahni, B. (1936a) Wegener's theory of continental drift in the light of Palaeobotanical evidence. *J. Indian bot. Soc.*, 15: 31-32.

Sahni, B. (1936b) The Karewas of Kashmir. *Curr. Sci.*, 5: 10-16.

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Commentaria Herbarii

"Presidency College", Madras-5

Morpho-taxonomical Notes on the Escallonioideae, Part A. Nodal and Petiolar Vasculature

BY

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(Received for publication, August 16, 1954)

ABSTRACT

On the basis of nodal anatomy, the genera of the Escallonioideae fall into two categories, trilacunar and unilacunar. The patterns of vascularization of the petioles conform to definite norms for the two groups of genera. Many of such norms appear to have become established *independently* in the two categories.

Introduction

In 1891, Engler recognized seven sub-families—Saxifragoideae, Francoideae, Hydrangioideae, Pterostemonoideae, Escallonioideae, Ribesioideae, and Baueroideae—under the family Saxifragaceae. The number of generic elements known at that time was 69. During the next four decades several new genera were described and the same author monographed the family Saxifragaceae again (Engler 1930). He now accommodated a total of 80 putative generic elements in 15 sub-families—Penthoroideae, Saxifragoideae, Lepuropetaloideae, Parnassoideae, Tetracarpaeoideae, Pterostemonoideae, Iteoideae, Brexioideae, Kirengeshomoideae, Kanioideae, Baueroideae, Hydrangeoideae, Escallonioideae, Monyinioideae, and Phyllonomoideae. The recognition, organization, composition, and the increased number of the sub-families in the second revision appears to have been accomplished as a result of more critical studies on certain generic elements rather than as a concomitance of mere addition of newly discovered genera to the family. In other words, the essential difference between the first and second monographs appears to involve a shift of emphasis on the external morphological characters that are supposed to delimit the supra--generic taxons.

A perusal of the 1891 and 1930 revision of the family shows that such taxonomic readjustments have been instituted on a considerable scale in the family as a whole and also rather freely within certain individual sub-families. A clear example of such a sub-family is the Escallonioideae of the 1891 monograph, in which 21 genera formed the constituents. The important changes instituted in the 1930 revision may be stated briefly as follows:

1. Two genera (*Quintinia* and *Dedea*) are merged into a single one.
2. Three genera (*Tetracarpaea, Itea,* and *Phyllonoma*) are accommodated independently under the corresponding sub-families.
3. Three genera (*Brexia, Ixerba* and *Roussea*) are removed to yet another sub-family,—Brexioideae.
4. Two genera (*Corokia* from the *Cornaceae,* and *Pottingeria,* a new genus established by Prain, 1898) are included.

With these changes, the total number of genera under the sub-family Escallonioideae of 1930 becomes 16.

Opinions in regard to the status of some of the sub-families of the Saxifragaceae are varied. In spite of segregating the generic constituents under 15 sub-families (10 of them unigeneric!) Engler (1930) has not removed any of them from the Saxifragaceae. Hutchinson (1926), on the other hand, for example, not only raises the Escallonioideae, Ribesioideae (Grossulariaceae), and Hydrangioideae, to the ranks of independent families, but places them under the Order Cunoniales.

Although such changes may have often been accomplished after a critical and comprehensive analysis of taxonomic characters of the plant units involved, many a time they raise questions of a far deeper nature: Is a study of exomorphic characters alone enough to institute such changes? In view of the fact that all tissues, structures, and organs of the plant body have also been subjected to the impact of evolutionary modifications, are not the endomorphic features as important as the exomorphic characters in taxonomic and phylogenetic studies? If we consider the plant as an *organic whole,* do the data obtained by a study of the external and internal characters harmonize? In other words, do the evolutionary rates of specialization in the different tissues or organs of the plant body synchronize? And, do they or should they synchronize always and in every case? A critical evaluation

of the data obtained on these lines should guide the ultimate establishment of natural relationships and of taxonomic ranks.

Such considerations as these motivated the present study. Materials of 21 genera and of most of the species of the Escallonioideae (Engler, 1891) as well as of the two subsequently added genera, *Corokia* and *Pottingeria* (Engler, 1930) were available for examination; those of *Bernice* and *Colmeiroa* were not accessible.

Observations

Nodal Vasculature: The leaves of the majority of genera are arranged in an alternating manner on the stem excepting in a few (e.g., *Ixerba*, *Roussea*, sometimes in *Polysoma*) where they are opposite. Irrespective of the phyllotaxy, the genera fall into two distinct categories: *

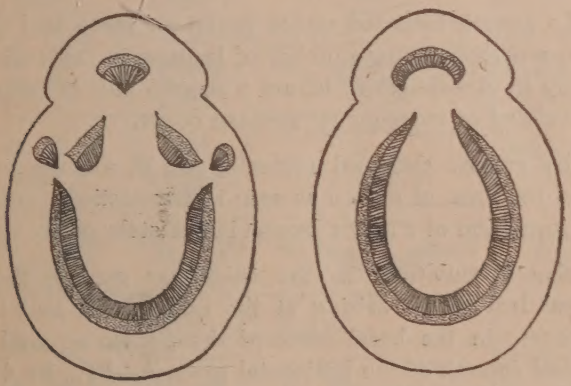

Fig. 1. Fig. 2.

FIG. 1. Transection of a trilacunar node.
FIG. 2. Transection of a unilacunar node. Both figures diagrammatic.

A. Those with trilacunar nodes (Fig. 1).
Anopterus (2)
Argophyllum (pentalacunar in *A. laxum*) (4)
Carpodetus (2)
Corokia (3)
Choristylis (2)
Cuttsia (1)
Forgesia (1)

* The number in perenthesis indicates the number of species examined under the respective genus.

Itea (5)
Ixerba (1)
Quintinia (9)
Roussea (1)
Valdivia (1)

B. Those with unilacunar nodes (Fig. 2).
Abrophyllum (1)
Brexia (1)
Escallonia (8)
Phyllonoma (1)
Polysoma (2)
Pottingeria (1)
Tetracarpaea (1)
Tribeles (1)

In the genera included under group A, three leaf traces are related to a corresponding number of lacunae in the eustele of the axis. Only in *Argophyllum laxum* a second pair of lateral traces that are related to independent lacunae occur.

In the genera classified under group B, a single leaf trace usually in the form of an arc as seen in transections, is concerned with the formation of a single lacuna in the stele of the axis.

Petiolar Vasculature: In the trilacunar genera, the median and lateral leaf traces arising at the nodal level maintain their distinctiveness in the basal parts of the petiole as well (Fig. 3, first vertical column of the horizontal rows, A—F). In *Anopterus, Argophyllum, Carpodetus, Choristylis, Corokia, Itea,* and *Ixerba,* the three vascular strands at higher levels become approximated along their lateral margins, and at the base of the lamina completely fused to result in a single shallow arc (Fig. 3 A). Although such a course appears to be a consistent feature for most of the species of the genera mentioned above, certain species exhibit considerable variability. Thus, in *Anopterus Macleyana,* (*White 1920**) the lateral traces which appear almost concentric at the basal level of the petiole (Fig. 3 E) slightly open out at higher levels and undergo fusion not only along their own adjacent sides but also with the free ends of the abaxially situated median trace

* The name and number mentioned against a specimen refer to the collector and field number respectively of the herbarium specimen examined.

so as to form an unbroken vascular cylinder; towards the base of the lamina, however, the cylinder opens out adaxially and appears in the form of a horse-shoe. In *Argophyllum ellipticum* var. *oblongifolium* (*Franc* 2431) and *A. laxum* (*Bonati* 642) (Fig. 3 F), the

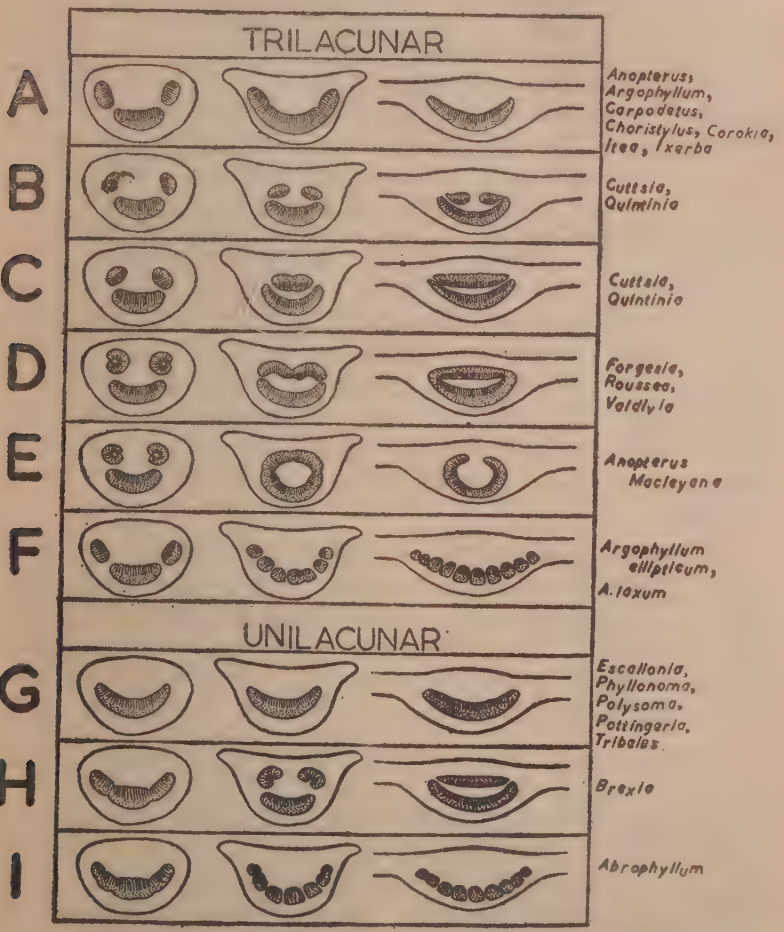

FIG. 3. Diagrams illustrating the petiolar vasculature. In each horizontal column are shown transections of petioles passing through the basal, middle and top levels of the petiole. All figures diagrammatic.

median and lateral traces become further split up into 10-15 smaller ones, all of them disposed in the form of a broken shallow arc.

The lateral traces in *Quintinia* and *Cuttsia* move towards each other along the adaxial side in the middle height of the petiole (Fig. 3, B and C). The further behaviour is subject to considerable degree of variation among the different species. In the majority of species of *Quintinia,* the lateral traces soon occupy an adaxial position and continue as such as far as the base of the lamina (Fig. 3 B), whereas in *Q. quatretagesii* (*# White 1923*) the two lateral traces fuse together along their adjacent faces (Fig. 3 C). These two conditions are seen to be present in the different collections of one and the same species of *Cuttsia viburnea,* as between *# White 9323* and *101921.* It is very probable that detailed studies may eventually prove that the variations mentioned above often may occur in the different leaves of one and the same branch.

In *Forgesia, Roussea* and *Valdivia* (Fig. 3 D), the lateral traces (in *Forgesia* these show a pronounced tendency to become concentric towards the basal level of the petiole) at higher levels move towards the adaxial side and undergo fusion along their adjacent sides, and the free ends in turn fuse with those of the adaxially disposed median trace, so that the petiolar vasculature in the neighbourhood of the lamina forms a dorsiventrally compressed cylinder.

Among the unilacunar genera, *Escallonia, Phyllonoma, Polysoma, Pottingeria,* and *Tribeles* exhibit a more or less stablized type of petiolar vasculature. The single leaf trace appearing as a shallow arc (Fig. 3 G) remains unchanged even at the basal level of the lamina. Only in *Phyllonoma,* the arc may assume a horse-shoe shape, with the opening situated towards the adaxial side.

In *Brexia* the leaf trace soon becomes split into three, a larger median and two laterals, the latter being either somewhat concentric (Fig. 3 H) or totally concentric. When they belong to the former category, the traces straighten out, fuse with each other, and the product lies towards the adaxial side at the basal levels of the lamina as shown in Fig. 3 H. On the other hand, when the lateral traces become totally concentric, the median trace forms an unbroken cylinder independently; the concentric laterals open out, undergo adjacent fusion, and come to lie on the adaxial side at higher levels of the petiole.

The leaf trace of *Abrophyllum* at lower levels of the petiole becomes broken up into a number of smaller traces (Fig. 3 I) and continues as such in the basal part of the costa.

Discussion

In the past, three workers have contributed towards an elucidation of nodal and petiolar anatomy of some of the saxifragaceous representatives. Thouvenin (1890) examined *Abrophyllum, Anopterus, Escallonia, Phyllonoma,* and *Quintinia;* Morvillez (1918) studied *Polysoma* and *Phyllonoma;* and Watari (1939) worked on *Carpodetus, Corokia, Escallonia,* and *Quintinia.* The number of representatives studied by these authors and the forms examined at present add up to a fair sampling of the Escallonioideae. *

As has been mentioned on a previous page, the genera of the Escallonioideae fall into two categories, trilacunar and unilacunar. The occurrence of a pentalacunar condition in one species of *Argophyllum* does not preclude its inclusion under the trilacunar category, as such a feature sporadically crops up here and there throughout the trilacunar dicotyledonous representatives. The two conditions are sometimes seen in the same plant, trilacunar in the normal leaves and a varying degree of expression of the multilacunar condition in the more vigorously growing or unusually large leaves.

In contrast to the rather stabilized behaviour of the nodal vasculature, the pattern of vascularization of the petioles is somewhat plastic. Although there appear to be definite norms for certain groups of genera (Fig. 3), quite often the different species (or, at times one and the same species) exhibit considerable fluctuation that vary around the norm characterizing the majority of taxons involved.

Results of the present study furthermore illustrate clearly the parallel trends of modifications in the vascularization patterns of

* The composition of the Escallonioidean genera is very varied in regard to the specific taxons. The genera that involve more than one species are: *Escallonia* and *Polysoma* (50 species in each), *Quintinia* (15 species), *Itea* (11 species), *Argophyllum* (10 species), *Carpodetus* (7 species), *Phyllonoma* (6 species), *Corokia* (3 species), *Anopterus* and *Choristylis* (2 species in each). The remaining 12 genera are unispecific. The total number of species thus far investigated under the first five large genera are as follows: *Escallonia* and *Polysoma,* 18 and 16 respectively; *Quintinia,* 10; *Itea,* 8; *Argophyllum,* 7; *Carpodetus* and *Phyllonoma,* 6 in each. Information is available on almost all species of the remaining genera.

the petiole in the representatives of the trilacunar and unilacunar categories. Thus, the ontogenetic behaviour of the petiolar behaviour in *Anopterus, Argophyllum, Carpodetus, Choristylis, Corokia, Itea,* and *Ixerba* (all trilacunar) is exactly similar to the condition seen in *Escallonia, Phyllonoma, Polysoma, Pottingeria,* and *Tribeles* (compare A and G of Fig. 3); those of *Cuttsia* and *Quintinia*) (trilacunar) correspond to the situation in *Brexia* (unilacunar) (compare C and H of Fig. 3); and the pattern of *Argophyllum ellipticum* and *A. laxum* (trilacunar) is identical with that of *Abrophyllum* (unilacunar) (compare F. and I of Fig. 3). Therefore, in discussions of similar and dissimilar relationships of taxons a full knowledge of the vascular pattern not only of the petiole, but also of the node, becomes very essential to arrive at accurate conclusions.

To what extent these observations in regard to the vascular anatomy of nodes and petioles of the Escallonioideae tie in with data obtained from a study of other endomorphic features will form the subject matter of subsequent contributions in this series.

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A Calciferous Amphibole from a Xenolith in Granite

BY

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ABSTRACT

Hornblende from an amphibolite, occuring as xenolith in granite of Kattriguppe, Bangalore district, has been chemically analysed and its optical characters determined. The Niggli values of the analysed mineral lie within the range of values given for common hornblendes. W, X, Y, Z, values of the analysed mineral are compared with Berman's classification of common hornblendes. These values of the analysed mineral lie between those of hornblende-edenite and Hastingsite. The values of (Na, K), Al, Fe''', and Ca are plotted on the miscibility diagram of Sundius. The plotted point lies midway between Pargasite and edenite indicating that the amphibole is composed of the molecules pargasite and edenite.

Horblende from an amphibolite, occuring as xenolith in granite of Kattriguppe, Bangalore district, Mysore state, has been chemically analysed and its optical characters determined. The amphibolite is dark-green in colour. Megascopically it is very hard, compact, fine-grained and fresh-looking. It occurs as xenolith incorporated in granite. The felspars of the amphibolite range in anorthite content from 25%-50%, while the anorthite content of the felspars of the granite ranges from 16%-30%. The optic axial angle of the plagioclase felspars were $2V = -78°$ to $-86°$. Many of the plagioclases are untwinned. At the contact zone between amphibolite and granite are abundant sphene. The sphene is honey-brown in colour, shows high dispersion, and has an optic axial angle $+2V = 40°$. Twinning on (100) is present. The granite portion shows equigranular texture, while the amphibolite portion shows granulitic texture.

Optical:—Hornblende occurs as porphyroblasts and also as well-developed tabular and prismatic grains. The average grain size of the hornblende varies from 0·16m.m-0·64m.m. It is yellowish-green in colour, with well-developed (110) cleavage. Twinning on (100) is also common.

The refractive indices were determined in refractive index liquids from the powder used in chemical analysis. The indices α and γ were determined on cleavage flakes parallel to (010). The index β was determined on grains perpendicular to an optic axis. α, γ were also determined by the method of birefringences (Hess, 1949), from the known value of β, the average of 10 determinations being entered. These values are fairly in agreement with the values for α and γ, determined by immersion method. Optic axial angle is the average of 22 determinations on Universal stage, on sections showing the emergence of both the optic axes. The value of the optic axial angle was also computed from the refractive indices. This is fairly in agreement with the values measured. Z Λ C is the average of 16 determinations from stereographic projection. Extinction angle was also determined on the microscopic stage, using hornblende sections parallel to an optic plane. Orientation was determined by plotting the co-ordinates of the two cleavages, and drawing the optic axial plane on the projection. The optic plane bisects the obtuse angle, hence it is parallel to (010), and Y = b.

Refractive Indices:—

$\left.\begin{matrix}\alpha = 1{\cdot}652\\ \beta = 1{\cdot}669\\ \gamma = 1{\cdot}676\end{matrix}\right\}$ By Immersion method $\left.\begin{matrix}\alpha = 1{\cdot}653\\ \gamma = 1{\cdot}675\end{matrix}\right\}$ By Birefringence Method.

$(\gamma\text{-}\alpha) = 0{\cdot}022$, $(\gamma\text{-}\beta) = 0{\cdot}006$, $(\beta\text{-}\alpha) = 0.016$, $^{-2v}$ meas = 62°, $^{-2v}$ cal = 60° 18′ Z Λ C = 20° (average of 16 determinations), X = Yellow, Y = yellowish-green, Z = Dark green X<Y<Z, Y = b, sp. Gr-= 3·18.

Chemical:—Hornblende was repeatedly separated in bromoform and then in clerici's solution diluted with water. The hornblende analysed was almost pure, except for a few minute flakes of biotite mica which could not be separated.

The chemical composition, C.I.P.W. Norm and Niggli Basis are given below.

	Constituents.	Wt. %.	Mol. Props.	No. of (O, OH, F)	No. of Metal atoms to 24 (O, OH, F)		Valency Check.	
1.	SiO_2	44·52	0·742	1·484	6·685	}	Si++++	= 26·740
2.	TiO_2	0·75	0·009	0·018	0·081	} =8·00	Ti++++	= 0·324
3.	Al_2O_3	10·17	0·100	0·300	1·234		Al+++	= 5·406
					0·568		Fe+++	= 1·134
4.	Fe_2O_3	3·38	0·021	0·063	0·378		Fe++	= 3·352
5.	FeO	13·40	0·186	0·186	1·676	} =5·325	Mn++	= 0·180
6.	MnO	0·07	0·010	0·010	0·090		Mg++	= 5·226
7.	MgO	11·62	0·290	0·290	2·613		Ca++	= 3·802
8.	CaO	11·85	0·211	0·211	1·901	}	Na+	= 0·720
9.	Na_2O	2·47	0·040	0·040	0·720	} =2·837	K+	= 0·216
10.	K_2O	1·06	0·012	0·012	0·216	}		
11.	H_2O+	0·79	0·050	0·050	0·901	=0·901	Total	47·100
12.	H_2O-	0·12						
	Total	100·20		2·664			0H =	0·901
							0 =	46·198
							Total	47·099

$$F = \frac{24}{2 \cdot 664} = 9 \cdot 009$$

Warren's formula for the mineral is:—

$(OH)_{0 \cdot 901}$ (Na, K, Ca)$_{2 \cdot 837}$ (Mg, Mn, Fe‴, Fe″, Al)$_{5 \cdot 325}$ (Si, Ti, Al)$_{8 \cdot 00}$ $O_{23 \cdot 099}$.

C. I. P. W. Norm.		%	Niggli Basis Mols.		%
Orthoclase	=	6·67	Kp	=	4·01
Albite	=	2·62	Ne	=	13·34
Nephelene	=	9·94	Cal	=	8·03
Anorthite	=	13·34	Cs	=	13·67
		18·91	Fs	=	3·51
Diopside	=	7·79	Fa	=	16·40
		10·40	Fo	=	24·24
		13·02	Ru	=	0·50
Olivine	=	11·02	Q	=	16·30
Magnetite	=	4·87	Q	=	16·30%
Ilmenite	=	1·37	L	=	25·38%
Water	=	0·91	M	=	58·32%
Total		100·86	Total		100·00

The Niggli Basis for this mineral does not correspond with the values given for basaltic and alkali hornblendes, but lies within the range of values given for common hornblendes (Burri & Niggli, 1945, Table 9, p. 69-70).

Niggli values for the amphibole.

	Si	al	fm	c	alk	Ti
Analysed mineral	83	11	59	24	6	1
Niggli values for Common hornblendes.	75-101	6-17	52-66	21-29	2-7	var.

Compared with Winchell's (1924) molecules, the metasilicate molecules of the analysed mineral correspond to a hornblende quoted by him, (Winchell, No. 9).

Molecules.		Analysed Mineral	Winchell's No. 9 p. 284
$Ca\ Mg\ Si_2O_6$	..	27·16	29·38
$Ca(Fe, Mn)Si_2O_6$	..	20·33	19·86
$Mg\ SiO_3$	..	16·10	15·13
$(Fe, Mn)\ SiO_3$	..	15·05	10·78
$(Na, K)\ Al\ Si_2O_6$	..	5·37	...
$(Na, K)\ Fe\ Si_2O_6$	..	...	...
$(Na, K)\ AlO\ (O, OH)_2$	..	8·10	11·21
$Al\ AlO_3$	..	4·90	7·67
$Fe\ FeO_3$	..	4·87	7·25
Total	..	101·88	101·28
H_2O Deficit	..	0·51	1·08
Total	..	101·37	100·20

Compared with Hallimond's study of amphiboles it agrees with No. 92, (Hallimond 1943, p. 83) and shows a paragenesis with granodiorite.

	Si	Ti	Al	Fe‴	Fe″	Mg	Ca	Na	K	OH	V.S	V
Analysed Mineral	668	8	180	38	167	261	190	72	21	90	85	284
Hallimond's No. 92, p. 83.	662	9	188	54	166	246	196	68	24	70	88	...

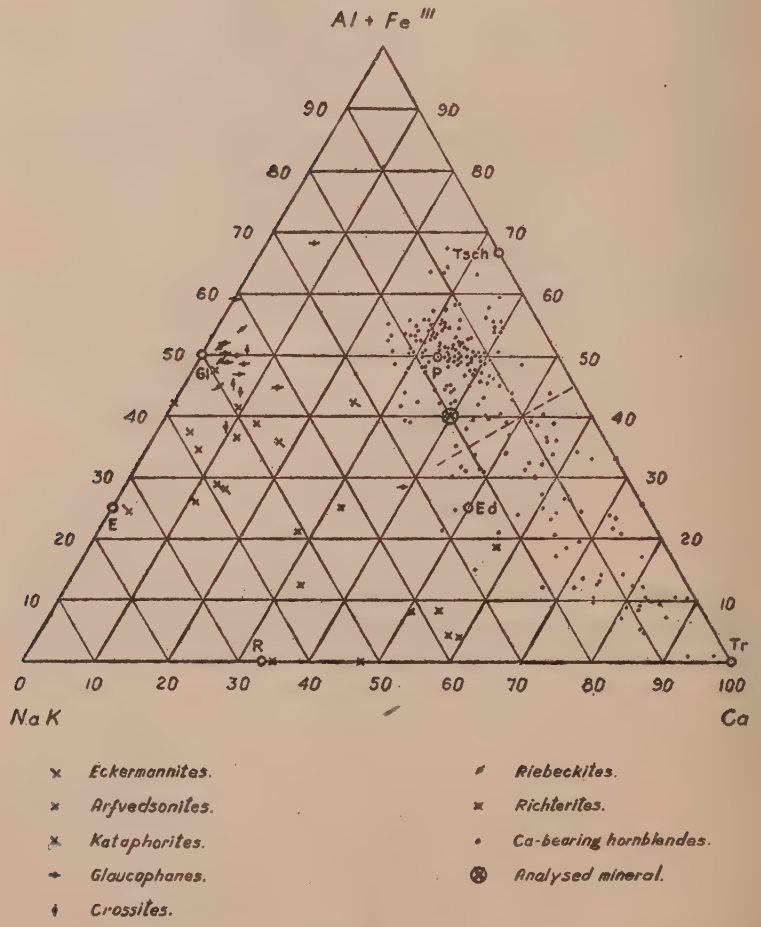
Berman has classified the amphiboles as follows:—

W	X	Y	Z = (Si, Al)	
3	5	0	7 : 1	Hornblende-Edenite.
3	4	1	6 : 2	Hastingsite.
3	3	2	8 : 0	Glaucophane.
3	4	1	8 : 0	Arfvedsonite.

The values W, X, Y, Z, calculated for the analysed mineral lie between those for hornblende-edenite and hastingsite, and the chemical analysis is close to No. 5, hastingsite of Buddington and Leonard (1953), but for the refractive indices.

	W	X	Y	Z=(Si, Al)
Analysed Mineral	2·84	4·38	0·95	7 : 1
Buddington and Leonard, No. 5 (D_8).	2·44	4·00	0·94	6 : 2

Sundius (1946) has studied the miscibility relationship of calciferous amphiboles. Plotting the values (Na, K), Ca, Al, Fe‴, on his diagram, the point of the analysed amphibole takes a position midway between pargasite and edenite in the less miscibility field. It is inferred thereby that the amphibole under study is composed of the molecules pargasite and edenite.



I hereby express my deep sense of gratitude and sincere thanks to Dr. P. R. Jagapathy Naidu, for his valuable guidance and suggestions in preparing this paper.

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Shonkinites from the Ultrabasic Areas of Salem

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ABSTRACT

Potassic rocks, shonkinites, rather rare rock-types in the world, have been discovered by the author from the ultrabasic areas of Salem. Their chemical analyses and optical characters are reported. The petrogenesis of the rocks is discussed.

Potassic rocks have been reported from the Bufumbira Area of Uganda by Holmes and Harwood (1932), from the West Kimberley Area of Western Australia by Wade and Prider (1940), from Java and Celebes by Iddings and Morley (1915) and from a few other places by other authors. The Potassic rocks from Bufumbira are all lavas, leucite-basalts, leucite-basanites and Potash-trachy-basalts overlying a thick series of Precambrian sedimentary rocks. Wade and Prider report from West Kimberley, potassic rocks occuring as plugs, dikes and flows, overlying palaeozoic sediments. The rocks are invariably abundant in leucite, reaching a maximum of about 60% in the modal composition. Iddings and Morley have analysed eight types of leucitic rocks from Mt. Mouriah, said to be an extinct volcano, and have described them. They also describe several occurrences of shonkinites in the form of intrusive bodies in Java and Celebes. Weed and Pirsson (1901) have described the Shonkin Laccolith in Highwood Mts. and refer particularly to a rock of granitic texture in the Square Butte, which they name as shonkinites. The shonkinite differs from all other occurences noted above, which are all lava flows.

Two specimens of potassic rocks have been collected by the author from Salem, R.35—Grid 77½/66 and R. 40 76/66 (58 I|2).

Petrography

The rocks are plutonic, dark-coloured, medium-grained and fairly fresh-looking at the surface. R.35 is dark-grey and has

a porphyritic texture with phenocrysts of augite and other femic minerals embedded in a felsic matrix. R.40 is much darker in colour, with large phenocrysts of diopside and biotite set in a groundmass of fine-grained, dark-coloured minerals with small interspaces of felsic material.

In thin section, R.35 is found to consist of coarse-grained, euhedral and subhedral plates of augite (5 mm. × 3.9 mm. to .09 mm. × .07 mm.), Diopside-Jadeite (6.24 mm. × 2.93 mm. to .09 mm × .07mm.) and olivine (2.73 mm. × 1.37 mm. to .29 mm. × .20 mm.) together with minor amounts of biotite-mica (.27 mm. × .16 mm. to .03 mm. × .02 mm), while the felsic mineral is laths of orthoclase. Orthoclase is in the form of untwinned laths (1.66 mm. × .29 mm.), in simple twins of two individuals (1.17 mm. × .16 mm. to .16 mm. × .06 mm.) and also occurs as multiple twins of more than two individuals. Orthoclase is at places intergrown with eleolite such areas being .98 mm. × .98 mm. Occasional grains of microcline are also seen. The accessory minerals are apatite and ilmenite.

R.40, in thin section, appears to be porphyritic, with phenocrysts of subhedral to anhedral femic minerals set in a groundmass of massive orthoclase which extinguishes over large areas. Occasional grains of eleolite (1·56 mm. × 1.37 mm. to .20 mm. × .12 mm.) and intergrowth of eleolite and orthoclase (3.12 mm. × 1.76 mm.) are also seen. The phenocrysts include, besides Diopside (1.56 mm. × 1.37 mm. to .20 mm. × .10 mm.) and Diopside-Jaedite (2.14 mm. × 1.17 mm. to .11 mm. × 10 mm.), olivine (1.95 mm. × 1.17 mm. to .10 mm. × .10 mm.) and mica (1.56 mm. × .49 mm. to .20 mm. × .10 mm.) Mica in this rock is in large flakes and is more abundant than in the previous rock. The accessories are ilmenite, apatite, and melilite.

Mineralogy

R. 35 : *Orthoclase* : The laths of felspar, when their optical constants are plotted, coincide with Nikitin's stereogram for orthoclase. The individuals of the twins are found to be twinned according to complex carlsbad law. The optic plane is normal to (010). The laths are uniaxial to biaxial. The optic axial angles vary from $-2V = 0°$ to $-2V = 39°$. The refractive indices are $\alpha = 1.520$, $\beta = \gamma = 1.524\text{-}1.526$

$$\gamma - \alpha = \cdot 005.$$

There has been some difficulty in naming this mineral as orthoclase. Dana (1951, p. 537) states that the optic axial plane is ⊥ (010) in adularia and that it is ∥ (010) in sanidine and that the optic axial angle is small in sanidine but about 70° in adularia. He does not give separate data for orthoclase. Winchell (1951, p. 303, p. 306) states that in orthoclase the optic axial plane is ⊥ (010) and that the optic axial angle is usually 60°-85°; in sanidine, the optic axial plane is ⊥ (010) or ∥ (010), and that the optic axial angle is 0°-small. Barth (1952, p. 97) makes a clear distinction between orthoclase and sanidine, the optic axial plane in the former being ⊥ (010) and in the latter ∥ (010) and the optic axial angle 0°-40° in orthoclase and 0°-30° in sanidine. The data of Barth are followed here and the mineral is named orthoclase.

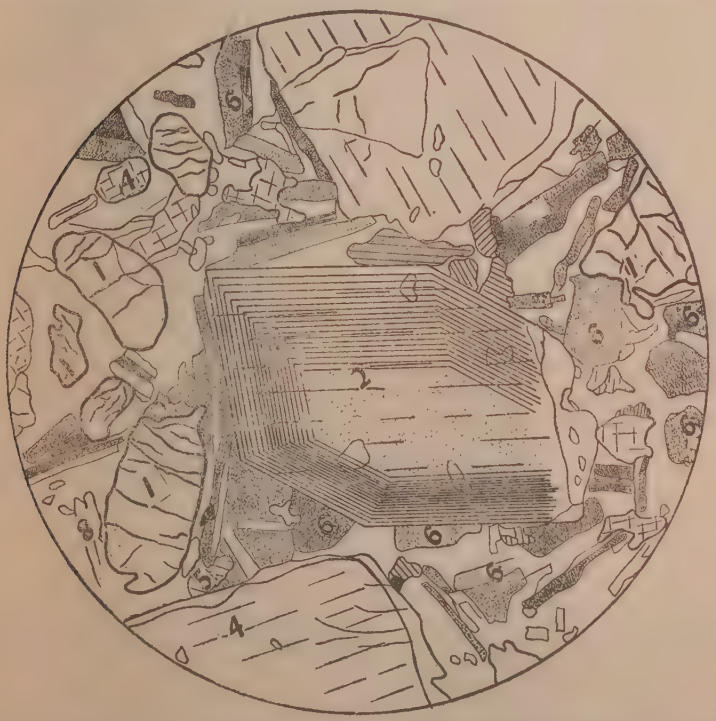

FIG. 1. Showing Zonary banding in augite. The bands, sometimes as many as thirty-five in number, show slight variation of extinction angles. The augite is poikilitic with olivine. The different shades of mottling in orthoclase indicates twinning after carlsbad law.

1. Olivine. 2. Augite. 4. Diopside-Jadeite. 5. Biotite. 6. Orthoclase.

Some of the untwinned grains of orthoclase are intergrown with eleolite. Orthoclase is poikilitic with needles of apatite and all the earlier-formed mafic minerals.

Augite: The mineral occurs as euhedral to subhedral plates, with distinct cleavages. There are a few grains twinned on (100). The average extinction angle measured on two such twins by the method of Nemoto and Turner (Hess. 1949) gave $Z\Lambda C = 42.5°$. The other optical characters are: $+ 2V = 59°$. $\gamma - \alpha = .027$, $\beta\text{-}\alpha = .008$ and $\gamma\text{-}\beta = .019$ $\beta = 1.688\text{-}1.691$. The augite is poikilitic with olivine and is often traversed by veins of massive orthoclase, which convert augite into minute shreds of biotite. The augite grains are

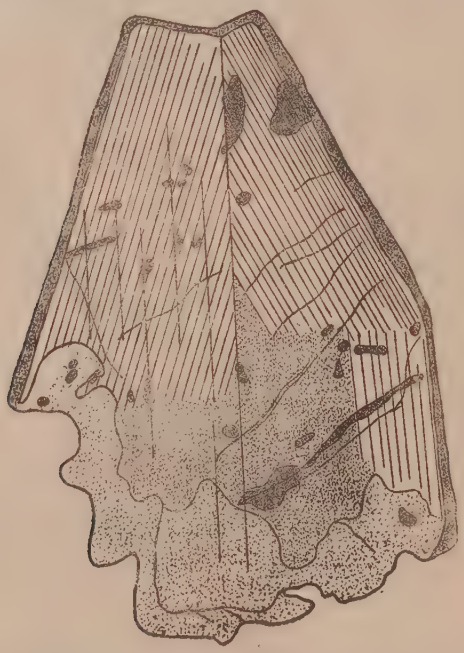

Fig. II. Herring bone structure in twin of augite, twinned after(100). The bands are parallel to the prismatic faces of the two individuals.

zonally banded, the bands sometimes being as many as 35 in number. These bands show slight variation of extinction angles (Fig. I). When the grain is twinned on (100), the bands of the two halves give a herring-bone like structure under crossed nicols (Fig. II). The augite also shows reaction rims and sometimes

extinguishes in patches. Optic axial angles and birefringences were measured on the rim and the core of the zoned individuals.

The data are:

Core of the grain: $+2V = 59°$, $\beta - \alpha = .0081$, $\gamma - \beta = .023$

Rim of the grain: $+2V = 61°$, $\beta - \alpha = .0083$, $\gamma - \beta = .019$

The rim therefore seems to be diopside-jadeitic in character.

FIG. III. Euhedral crystal of olivine showing zoning due to symmetrical arrangement of inclusions. The different shades of mottling in orthoclase indicates twinning after carlsbad law.

1. Olivine. 2. Diopside-Jadeite. 4. Augite. 5. Biotite. 6. Orthoclase.

Diopside-Jadeite: This mineral occurs more as long needles than as plates. It extinguishes in patches. The optic axial angle, $+2V = 69°$,

Olivine: Olivine being the earliest mineral to crystallise shows a strong tendency to euhedral outlines. This mineral is also zoned. Here the zoning is due to symmetrical arrangement of inclusions (Fig. III).

The general development of zoning in all these femic minerals shows a reaction relation between the earlier formed crystals and the residual melt and indicates a continual change in the composition of the magma. The patchy extinction in diopside-jadeite and the invasion of early-formed femic minerals by potash-liquid denotes a later hydrothermal alteration.

Olivine is found to be colourless and contains inclusions of magnetite. $-2V=86°$ $\gamma-\beta = .022$. $\beta-\alpha = .025$ $\beta = 1.683-1.686$. It is, therefore, Forsteritic in character.

Mica: Mica of the biotite variety develops at the expense of mafic minerals and in the neighbourhood of orthoclase. It also occurs as a reaction rim to grains of ilmenite attacked by potash liquid. It is apparently developed from olivine by taking magnesia while orthoclase is the feeder for the potash part of it. The mica has a core of ilmenite, in most of the grains. Biotite is of the reddish brown variety and is pleochroic. x = straw yellow, y = z = reddish brown.

R. 40. *Orthoclase and eleolite*: Orthoclase and eleolite in this rock form the groundmass in which phenocrysts of the femic minerals occur. Unlike in the previous rock, orthoclase is never found twinned. The mineral is clouded and patchy in appearance. Some of the patches are brown and are pleochroic from light-brown to dark-brown. X = dark brown, Z = light brown. The pleochroism is found to be due to minute inclusions arranged parallel to the prismatic faces as a consequence of which the absorption is maximum parallel to the prismatic faces. The (001) cleavage is well seen in many grains and the optic axial plane is found to be parallel to it. The murchisonite cleavage of orthoclase is also found to be developed, but is less marked. Along the (001) cleavage direction, some grains look lamellar owing to alternate light and brown streaks giving the appearance of twinning but under crossed nicols, there are no lamellae visible. These bands may really be the direction along which leaching has taken place. Sometimes, these bands intersect in two sets at an angle of about 100° suggestive of trapezohedral edges (Fig. IV). The optical characters are :

$X\Lambda a = 5°$

$-2V = 0°$ to $-2V =$ a maximum of 44°.

$\alpha = 1.520$. $\beta = 1.524 - 1.525$. $\gamma = 1.525 - 1.526$.

$\gamma - \alpha = .005$.

FIG. IV. Pleochroic patches of orthoclase are sometimes lammellar. These lamellae intersect occasionally in two sets at an angle of about 100° suggesting trapezohedral edges. Diagram without nicols crossed.

1. Olivine. 2. Diopside-Jadeite. 3. Diopside. 5. Biotite. 6. Orthoclase.

Needles of apatite and very minute needles of another mineral occur as inclusions. Needles of this other mineral have negative elongation, low birefringence, and are of uniaxial character. These are probably melilite.

Eleolite occurs as independent grains and is also found to be inter-grown with orthoclase (Fig. V).

Fig. V. Intergrowth between untwinned orthoclase and eleolite forming the groundmass enclosing phenocrysts of femic minerals.

1. Olivine. 2. Diopside-Jadeite. 3. Diopside. 5. Biotite. 6. Orthoclase. 7. Eleolite. 8. Apatite.

$\omega = 1.542$. $\varepsilon = 1.537$.

ω-$\varepsilon = .005$.

The eleolite crystals are abundant with minute inclusions which have positive elongation and have fairly high birefringence. These inclusions are those of sericite.

A case of eleolite and orthoclase in parallel growth was noticed. The stereogram of this growth is given in Fig. VI: (010) of Ortho-

clase and the prism face of eleolite constitute the plane of parallel growth. ε of eleolite coincides with β of orthoclase.

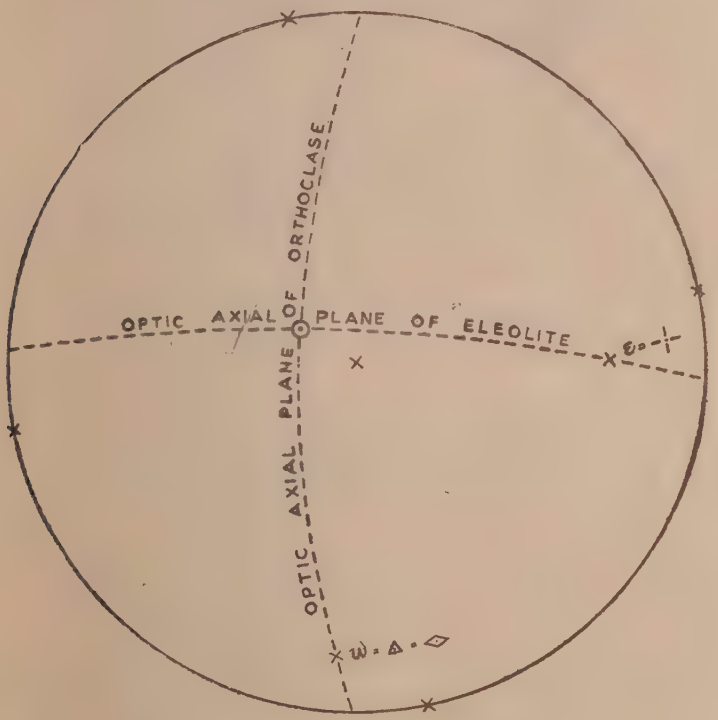

FIG. VI. Stereogram showing parallel growth of untwinned orthoclase and eleolite. The clinopinacoid of orthoclase and the prism face of eleolite form the plane of parallel growth.

ε coincides with β; ω coincides with γ and pole of association face.

Chemical: The two minerals were separated together from the others by using bromoform and bromoform diluted with benzene. A separation between eleolite and orthoclase was not possible even when powdered to 100 mesh. The mixture had specific gravity of 2.57. The mixture was anaylsed, the chemical composition of which is given below (Table I). The modal proportion of eleolite and orthoclase was determined micrometrically and is given below for

TABLE I

Chem-Comp		Norm.		Niggli Values		Basis Molecules		Mode*	
SiO_2-	57·41	Orthoclase	62·83	Si	195·7	Kp	36·56	Orthoclase	80·56
TiO_2-	Nil	Albite	3·93	ti	Nil	Ne	24·26	Eleolite	19·44
Al_2O_3-	22·29	Nepheline	19·17	al	45·17	cal	5·34		
Fe_2O_3-	0·38	Anorthite	9·17	fm	6·76	cs	1·14		
Feo-	0·51	Diopside: Cao. Sio_2	1·63	c	9·62	Fs	0·49		
Mno-	Tr	Diopside: Mgo. Sio_2	1·20	alk	38·45	Fa	0·54		
Mgo-	0·79	Diopside: Feo. Sio_2	0·26	K	0·6010	Fo	1·62		
CaO	2·66	Olivine: 2 Mgo. Sio_2	0·56	mg.	0·606	Ru	—		
Na_2O-	4·65	Olivine: 2 Feo. Sio_2	0·20	Q-	30·05	Q-	30·05		
K_2O-	10·59								
P_2O_5-	-Tr	Magnetite	0·46	L-	66·16				
H_2O+	0·55	Water	0·55	M-	3·79				
H_2O-	0·14								
	99·97		99·96						

* Average of measurement on three sections at ·5 mm. interval.

comparison. The ratio of eleolite to orthoclase in both norm and mode seems to be 1 : 4 which is, perhaps, the eutectic. The appearance of olivine, magnetite, and a portion of the anorthite goes to explain the presence of inclusions in eleolite while the remaining amount of anorthite with albite may be said to be present in solid solution with orthoclase.

Olivine: Olivine is colourless and is the next most abundant mineral in the rock. Some minerals are altered along cracks to serpentine. A number of grains are barrel-shaped. The mineral retains its crystallanity to a great extent.

$-2V = 87°$. $\beta = 1.678 - 1.680$. $\gamma - \beta = .022$. $\beta - \alpha = .027$.

The olivine grains have minute inclusions arranged parallel to the edges of the crystals.

Diopside: Diopside is light green in colour, occurring in the form of porphyritic plates, with distinct cleavages. It extinguishes in patches and has reaction rims. This is the most abundant femic mineral next to olivine.

$+2V = 60°$. $\alpha = 1.662$. $\beta = 1.669$. $\gamma = 1.690$.

Mica: Unlike in the previous rock, mica is abundant here and occurs as large independent flakes, although the occurrence of mica as a reaction between femic minerals and orthoclase is not uncommon. It is dark-reddish-brown in colour and is pleochroic. X = straw yellow. Y = Z = Dark reddish brown. It has a very small optic axial angle and sensibly uniaxial. Most of the grains have got a core of ilmenite.

$\alpha = 1.605$. $\gamma = \beta = 1.664$. $\gamma - \alpha = .059$.

Diopside-Jadeite: The mineral is normally indistinguishable from diopside, except by its zoning in patches and wavy extinction. $+2V = 72°$. $\alpha = 1.659$ $\beta = 1.664$ $\gamma = 1.671$.

Petrochemistry

Both the rock types were analysed. The chemical analyses are set below alongside those of others for comparison. The norm, mode and niggli values are also given.

	1	2	3	4	5	6	7	8
SiO_2 ..	50·55	48·87	50·00	48·98	46·04	44·89	45·77	47·50
TiO_2 ..	1·52	1·29	0·73	1·44	2·20	0·95	0·76	1·85
Al_2O_3 ..	6·97	9·44	9·87	12·29	12·40	12·73	8·94	9·62
Fe_2O_3 ..	0·29	2·33	3·46	2·88	3·54	3·31	3·63	3·37
FeO ..	7·93	7·57	5·01	5·77	5·58	4·35	7·13	4·74
MnO ..	0·43	0·42	Tr	0·08	Tr	...	0·13	Tr
MgO ..	13·11	12·15	11·92	9·19	12·60	13·71	12·96	13·00
CaO ..	12·22	9·57	8·31	9·65	8·38	12·85	11·56	9·00
Na_2O ..	1·97	2·61	2·41	2·22	1·62	1·02	1·40	1·96
K_2O ..	4·13	4·56	5·02	4·96	4·87	3·66	4·60	3·28
P_2O_5 ..	Tr	Tr	0·81	0·98	...	0·23	1·52	1·05
H_2O+ ..	0·33	0·44	1·33	0·82	3·55	1·86	0·95	3·90
H_2O- ..	0·06	0·16					0·18	0·90
Total ..	99·51	99·41	98·87	99·26	100·78	99·56	99·53	100·17

Norm:—	1	2	3	4	5	6	7	8
Or ..	17·79	23·91	29·5	29·5	25·0	0·6	17·24	19·46
Ab ..	...	...	8·9	5·3	...	...	...	16·77
An ..	...	0·28	1·1	8·6	12·2	19·2	4·17	7·51
Ne ..	7·10	11·93	6·2	6·8	7·4	4·8	6·53	...
Lc ..	5·23	2·62	...	...	3·1	16·6	7·85	...
Sod. Met. Silicate ..	0·61	...	...	...	...	...	...	...
Ac ..	0·92	...	...	...	...	...	...	...
Di. ..	48·69	37·88	28·9	26·5	23·0	33·9	34·4	23·55
Ol. ..	16·16	16·59	14·8	11·7	17·3	15·6	17·80	17·11
Mt. ..	...	3·25	5·1	4·2	5·1	4·9	5·34	4·87
Il. ..	2·89	2·43	1·4	2·6	4·3	1·8	1·37	3·50
ap. ..	...	...	1·7	2·2	...	0·6	3·70	2·69
Water ..	0·33	0·44	...	...	...	...	...	...
Total ..	99·72	99·28	97·6	97·4	97·4	98·0	98·34	95·46

Mode:—Orthoclase + eleolite.		Di.	Di-Ja.	Au.	Ol.	Bt.	Microcline.
R. 35	43·5	-	16·1	21·1	13·5	5·3	0·5
R. 40	47·7	13·9	8·1	-	16·8	13·5	-

The discrepancy between norm and mode (volume percentage) is due to the difference in density between salic and femic minerals. M = Vd. For eg. in R·35, taking orthoclase and eleolite, V = 44. d = 2·5; femic minerals, V = 56, d = 3·5.

$M = 44 \times 2 \cdot 5$ (salic) and $M = 56 \times 3 \cdot 5$ (femic).

Therefore, weight percentage of salic to femic = 36 : 64.

Similarly, in R·40 weight percentage of salic to femic = 40 : 60.

Niggli Values :—

	1	2	3	4	5	6	7	8
Si	103·8	102·3	111·4	115·3	97·70	106·1	91·70	105·4
al.	8·50	11·54	12·97	16·95	15·56	17·75	10·47	12·53
fm.	55·29	55·59	54·94	46·33	55·36	41·91	56·08	57·34
c	26·85	21·46	19·79	24·30	19·13	32·53	24·79	21·33
alk.	9·36	11·41	12·30	12·42	9·95	7·81	8·66	8·80
ti.	2·34	2·01	1·20	2·54	3·44	1·56	1·20	3·07
k	0·578	0·539	0·575	0·602	0·667	0·709	0·681	0·5304
Mg.	0·731	0·686	0·724	0·695	0·719	0·654	0·689	0·749

Basis :—

	1	2	3	4	5	6	7	8
Kp. ..	14·52	16·22	17·21	17·81	17·41	14·09	16·69	12·18
Ne. ..	8·25	13·91	12·67	12·03	8·79	5·86	7·66	10·79
Cal. ..	—	0·17	0·81	5·54	7·43	12·80	2·61	4·86
Ns. ..	1·14	—	—	—	—	—	—	—
Cs. ..	17·98	14·07	11·64	11·82	8·96	14·57	16·30	11·49
Fs. ..	0·33	2·32	3·57	3·05	3·72	3·72	3·81	3·65
Fa. ..	9·64	9·27	11·20	6·95	6·59	5·67	8·52	5·74
Fo. ..	27·05	25·17	24·18	19·33	26·36	17·68	27·37	28·02
Ru. ..	1·05	0·88	0·48	1·02	1·52	0·67	0·57	1·34
Q. ..	20·04	17·99	18·24	22·45	19·22	24·94	16·47	21·93
Q. ..	20·04	17·99	18·24	22·45	19·22	24·94	16·47	21·93
L. ..	22·77	30·30	30·69	35·38	33·63	32·75	26·96	27·83
M. ..	57·19	51·71	51·07	42·17	47·15	42·31	56·57	50·24

1. Shonkinite (R. 35), ultrabasic area, Salem. Analyst, Ramanathan.

2. Shonkinite (R. 40), ultrabasic area, Salem. Analyst, Ramanathan.

3. Shonkinite, montanose, Beauer creek, Bearpaw Mts. Analyst, Stokes, "Igneous rocks" by Iddings, Vol. II (1913) P. 280.

4. Shonkinite, Yogo pk., Little belt Mts; Mont. Analyst, Hille brand. "Igneous rocks" by Iddings, vol. II (1913) P. 285.

5. Mica leucite basalt, Oeloe Kajan, East Borneo, Analysts, Pisani and Brouwer, "Igneous rocks" by Iddings, Vol. II, (1913) P. 281.

6. Leucite-basanite, Fiordine, Montefiascone. Analyst, Washington. "Igneous rocks" by Iddings, Vol. II (1913) P. 288.

7. Lower Shonkinite, Shonkin Sag, Montana. Analysts, C. S. Hurlbut and D. Griggs, Igneous rocks of the highwood Mountains. (Part I, Geol. Soc. America Bull Vol. 52. No. 3. P. 1071, 1939).

8. Leucite-basalt, Todilto-park, Navajo province, Arizona. Analyst H. Williams, (Geol. Soc. America. Bull; Vol. 47. No. 6. P. 166. 1936)

From the above table, it is seen that the two rocks are close to shonkinite in chemical composition. Iddings describes shonkinites as "Phanerites characterized by alkali felspar and equal, or nearly equal, amounts of mafic minerals with small but notable amounts of felspathoids, nephelite or sodalite. The alkali felspar in the original shonkinite is orthoclase, and the rock was defined by Pirsson in terms of orthoclase." Since these chemical characters and generally the mineralogical characters agree closely with those found in the two rocks under discussion, the author proposes to call them as shonkinites.

Origin

The origin of potassic rocks has been brilliantly summarized by Barth (1952) and Turner and Verhoogen (1951). These seem to fall under three headings: (a) By normal differentiation from basaltic magma, (b) Assimilaiton by basaltic magma or peridotite magma of sediments or granitic shell and (c) By thermal diffusion.

All these theories of the origin of potassic rocks, however, refer chiefly to the origin of leucite-bearing lavas. The problem here is to account for the origin of orthoclase-bearing ultrabasic plutonic rocks.

The origin of potassic volcanic rocks have been explained as follows:

Bowen believes in differential fusion of biotite in contact with hot basaltic magma to change the composition of the magma in the direction of the potash-rich types. This theory has been objected to since biotite is not a mineral to accumulate in such great quantity in spite of its tabular crystal habit, as to give rise to a potash-rich magma from an olivine-basalt magma.

Daly's limestone-assimilation hypothesis to explain the origin of alkaline rocks in general, is well known.

Rittmann has modified Daly's hypothesis and has proposed different sequences to explain the lavas of the Somma-vesuvius volcano.

Larsen, while discussing the origin of the potassic rocks of the Highwood province, explains the rock types as products of magmatic differentiation modified by assimilation of the granitic basement.

Williams talks in terms of an original sodic ultrabasic monchiquite magma reacting with the potash felspar of the granitic basement and giving rise to the potassic composition of the rock types in the Navajo-Hopi province of Arizona.

Holmes first proposed a process of crystallization-differentiation of a primary peridotite magma to account for the origin of leucite-bearing lavas of East Africa. Subsequently he rejected the hypothesis on the ground that the two rock-types he derived from the magma were genetically proved to be unrelated to each other.

Later he (Holmes, 1937) postulated a complex process of "transfusion" to explain the potassic ultrabasic rocks. On studying the xenoliths of the various lavas, he assumed "highly energized" alkaline emanations as ascending from depth to react with the crustal material to produce the varieties of rock-types displayed in the Bufumbira area. This theory has been criticised on the ground that the ultrabasic xenoliths are more likely to be a product of direct crystallisation from parent magma than be a result from

a complex process of differential fusion. Turner and Verhoogen (1951) prefer to consider this theory as one concerning the origin of magmas in general. Nevertheless, it is a standing hypothesis to explain the potash-rich ultrabasic rocks.

Since the area under discussion consists of ultrabasic plutonic rocks—dunites, serpentines, magnesite-veins, eclogites, pyroxenites, mica-peridotites etc., and of no lavas, there is no possible connection between the potassic rocks under study and a basaltic magma. Further, Barth (1952), has indicated a method, whereby, rocks not belonging to a crystallisation-differentiation series, could be represented in a ternary diagram. His diagram of Kp-Ne-Q is herein reproduced, and the analysed rocks plotted (Figure VII).

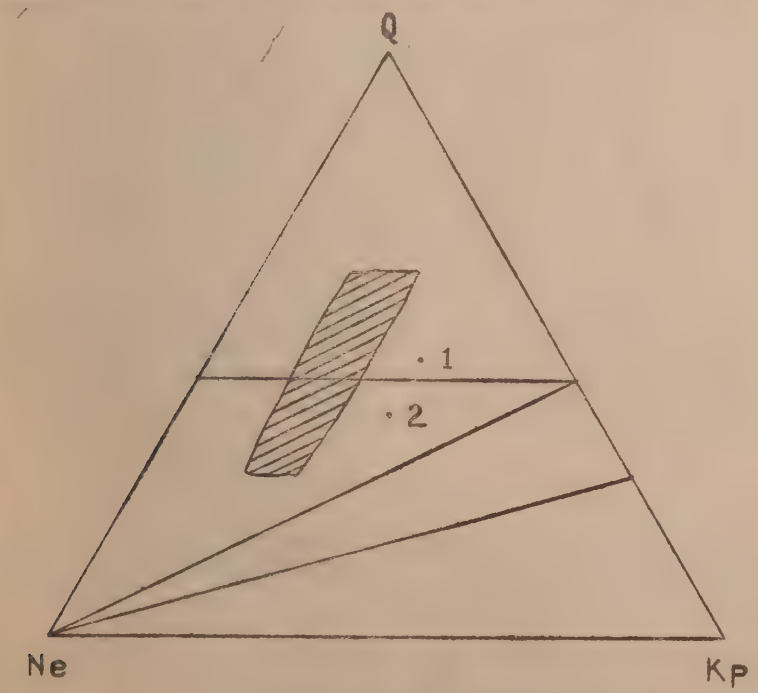

Fig. VII. 1 = R·35. 2 = R·40.

Q-Kp-Ne diagram after Barth, showing the trough of the "residua system". Both the rock types under discussion fall outside the trough which is the field of common igneous rocks.

Both the points lie outside the trough, thereby indicating that the rocks are not derived from the "residua system". The only rele-

vant relation seems to be to that of a peridotite magma. The derivation of potassic rocks from a peridotite magma has been excellently postulated by Holmes (1937). A similar theory is found feasible to account for the origin of these rocks.

A primary peridotite magma differentiating towards mica-peridotite can be assumed. Eskola's work shows that "aggregates of eclogite crystallise at a very early stage from peridotite magma when the pressure is sufficiently high. Another early product to crystallise is enstatite or clino-enstatite. Early separation of enstatite from peridotite magma has the effect of impoverishing the uncrystallised residue in silica".

The resultant magma may be somewhere about the composition of a pyroxene peridotite. From such a magma we have got the early crystals of olivine, diopside and augite separated, which occur in the form of coarse phenocrysts in the rock. With this magma under crystallisation, we may assume highly energized emanations containing potash to rise from depth and to react and metasomatise. The metasomatic liquid has affected the diopside converting it into diopside-jadeite in patches, as seen typically in these shonkinites. Reaction rims around olivine and augite and the zonary banding seen in augite are all igneous textures still preserved. Since the metasome had been rich in alkalies, it reacted with the crystallising magma to produce orthoclase and the intergrowth of orthoclase and eleolite to form the groundmass to the earlier crystallised femic constituents.

ACKNOWLEDGEMENT

The author is highly indebted to Dr. P. R. J. Naidu and takes this opportunity to acknowledge his help throughout the work and for having suggested this problem.

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An Agromyzid Insect Pest of "Bhendi"

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ABSTRACT

This article records the first occurrence of *Agromyza obtusa* Mall. (the red-gram or 'turpod' fly) as a pest of 'bhendi', *Hibiscus esculentus* L., in S. India. The maggot bores through the stem tissue of young plants and side-shoots of mature plants resulting in the wilting and death of the affected plants or branches. Considerable damage is at times caused by this pest. All varieties examined are susceptible, but a few with a profuse hairy growth on the stem appear to be comparatively resistant. Spraying the plants with either BHC or DDT (0·05 or 0·1 per cent.) at fortnightly intervals controls the pest to an appreciable extent.

The maggot of a fly belonging to a species of *Agromyza* was observed by one of us in 1947 to infest and kill young 'bhendi' (*Hibiscus esculentus* L.) plants in the experimental plots at the University Botany Laboratory, Madras. Later, it was seen at the Agricultural Research Institute, Coimbatore to cause considerable damage to developing side-shoots of mature plants. Several pests of 'bhendi' have been reported (Ramakrishna Ayyar, 1940), but this appears to be the first record of an agromyzid insect pest of this vegetable crop. A brief account of the pest, the nature of the damage caused and the possible methods of control is given in this communication.

The Insect.

The insect is placed in the genus *Agromyza* and is identified as *Agromyza obtusa* Mall. by the Head of the Division of Ento-

mology, Indian Agricultural Research Institute, Delhi to whom the authors' grateful thanks are due. This species, first described by Mallock as early as 1914, has been known for several years as an important and widely distributed pest of red-gram or pigeon-pea (*Cajanus cajan* (L.) Millsp.) in this country; damage to the red-gram seed to the extent of 60 per cent. has been reported by Ahmad (1938). It is believed that this pest has not been recorded hitherto on any other crop in this part of the country.

Text Fig. 1.

TEXT FIGS. I & II. Show wilting of leaves. A larva and a pupa are shown in Text-Fig. II. TEXT FIG. III. Egg. TEXT FIG. IV. Larva. TEXT FIG. V. Pupa.

Life-history of the insect as observed on 'bhendi.'

Copulation and oviposition: The flies copulate a day after emergence and copulation lasts for about four hours, followed by oviposition. The female pierces with her ovipositor the tender main stem of the seedling plant or the side-shoot of the mature

PLATE I

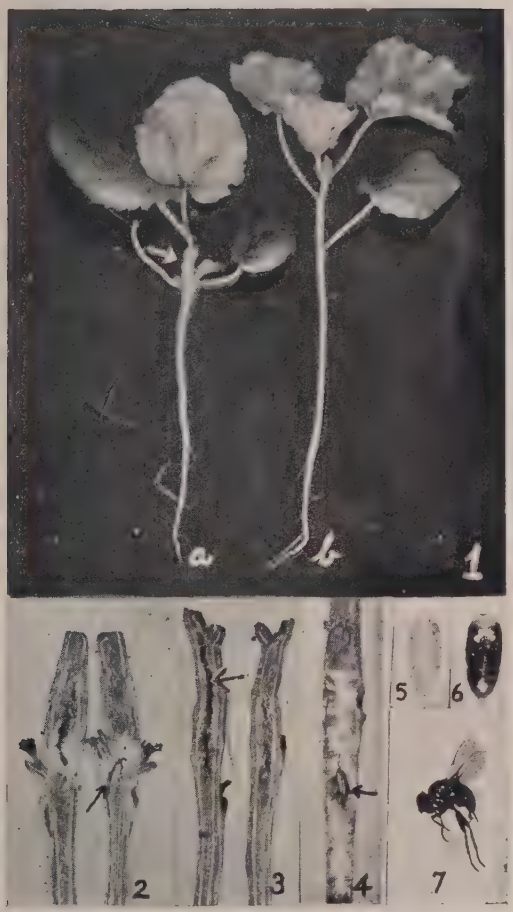

Fig. 1. (a) Young 'bhendi' plant infested with *Agromyza obtusa*. Note the characteristic swelling of the stem indicated by the arrow.
(b) Healthy plant.

Figs. 2 & 3. Note the tunnel or burrow caused by the maggot. A maggot (indicated by the arrow) is seen in Fig. 2.

Fig. 4. Note the swollen stem and a crack in it exposing a pupa.

Fig. 5. Empty pupal case (× 3, approx.)

Fig. 6. A mature, live pupa (× 3, approx.)

Fig. 7. An adult fly (× 3, approx.)

plant and lays a single egg. Usually one or two eggs are found in each shoot, but in rare cases as many as four to six are seen.

Egg stage: The freshly laid egg is white or yellow in colour and is laid inside the stem. It is broad and rounded at the posterior end, narrowed anteriorly into a curved and elongated hollow process (Text-fig. III). The egg stage lasts for three to four days.

Larval stage: The freshly hatched larva is white in colour, excepting for its mouth parts which are dark brown. The fully grown larva or maggot is pale white with pointed head-end and with chitinous mouth parts which are black in colour. It measures 3.2 - 4.1 mm. in length and 1.24 - 1.44 mm. in thickness. The head-end is truncate with two spine-like projections (Text-fig. IV). The larva feeds on the tissues of the stem and a hollow tunnel or burrow is formed (Plate I, Figs. 2 and 3). At the time of pupation, the fully grown larva approaches the epidermal layer of the stem and pupates in the tunnel. The larval period lasts for nine to eleven days.

Pupal stage: The pupa is yellowish white in colour when freshly formed, but gradually turns creamy yellow. It is cylindrical and broadly rounded at the ends (Plate I, Figs. 5 and 6; Text-fig. V), and measuring about 2.3 mm. in length and 1.32 mm. in thickness. Usually one to two pupae are seen in each infested shoot, but in one instance ten pupae were observed. The pupal stage lasts for eight to nine days.

Adult stage: The puparium gives way at one end and the fly forces itself out of it and breaks through the thin epidermal tissue of the stem which covers the entrance of the tunnel caused by the maggot. The longevity of the fly is very short, but it can be prolonged to about ten days by feeding the fly with a solution of honey. The adult fly is shiny black in colour and measures about 3 mm. in length.

Nature and extent of damage.

The maggot bores through the stem tissue and feeds on it. Young seedling plants are attacked at the topmost portion and the infested shoot can be readily spotted out by the characteristic swollen appearance of the affected part (Plate I, Fig. 1). Sometimes, the gall-like portion is split open longitudinally owing to the

pressure exerted by the developing pupa lying just beneath the epidermal tissue (Plate I, Fig. 4) The growth of the affected plant is stunted and the shoot portion above the infested region gradually withers. Wilting and death of leaves in the case of young plants and of entire shoots in the case of mature plants in which the side-shoots are infested (Text-figs. I and II) are the effects brought about by the pest.

The following table presents a summary of the data obtained on the extent of damage caused to young plants in different varieties of 'bhendi':

TABLE I

Showing the extent of damage to young plants.

Varieties	Stem smooth or hairy	No. of plants examined	No. of plants affected	% plants infested
1. Akasam	Smooth	20	12	60
2. P. 13	Smooth	20	9	45
3. Mullu	Hairy	20	3	15
4. Podugu	Smooth	20	16	80
5. Pal	Hairy	20	4	20
6. Dwarf green	Smooth	20	13	65
7. Long green	Smooth	20	7	35
8. Mullu X Long green	Hairy	20	4	20

All the varieties examined are susceptible to the pest, although the varieties 'Mullu' and 'Pal' and the hybrid 'Mullu X Long green' with very hairy stems appear to be comparatively resistant. It would be worthwhile to examine this aspect more critically.

Considerable damage to side-shoots in mature plants can be caused during a severe attack as the following data show:

TABLE II

Showing the number of shoots examined, percentage infestation and population counts of the different stages of the insect.

	No. of shoots examined	No. of shoots infested	% shoots infested	No. of maggots	No. of live pupae	No. of empty pupal cases
(1)	78	49	62·8	19	63	14
(2)	69	25	36·2	6	59	4
(3)	25	22	88·0	1	25	4
(4)	100	73	73·0	12	115	8
(5)	100	45	45·0	2	54	18
(6)	100	43	43·0	15	28	0
(7)	175	78	44·6	26	71	0
(8)	50	22	44·0	14	35	0
(9)	52	18	34·6	17	28	0

It is also observed that, in nature, the insect is to some extent parasitised by certain Braconids and Chalcids. Parasitism of the larvae by the Eulophid, *Euderus lividus* Ashm., has been reported by Ahmad (1940).

The fly can be considered to be a serious pest as well over 50 per cent. of the plants or branches are infested during a bad attack. The attack is more severe during the period July to November than during the cooler months of December and January. It must be noted, however, that in Madras in 1947 a severe attack of young plants was recorded during the period January to March; the pest was also seen at that time to infest pods of red-gram on plants growing in adjacent plots and the infestation had probably spread from the red-gram to the 'bhendi' plants.

Control.

The pest can be controlled to an extent by mechanical picking of infested shoots at the early stages of attack and destroying the maggots and pupae; this can only be done in the case of mature plants wherein the side-shoots are attacked. Preliminary spraying trials indicate that the pest can be kept under check by spraying the apparently healthy plants with either BHC or DDT (0.05 or 0.1 per cent.) at fortnightly intervals. Timely application of the insecticidal sprays, especially as a prophylactic spray in the case of young plants, may be expected to protect the crop from the ravages of the pest. This aspect of work is receiving further attention.

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Plagioclase Felspars of Granites, Gneisses and Associated Rocks of Jalarpet

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ABSTRACT

This paper deals with the anorthite content and twin-laws of the plagioclase felspars of granites and gneisses, collected from the *Yelagiri Hills* near *Jalarpet* Railway Station. From Tertsch's stereogram, the felspars of the Jalarpet series, are inferred to belong to the low temperature series. Cumulative diagrams are given for the anorthite content and various twin laws, observed in the series.

The Pericline twin occurs as fine lamellae across the albite twins,—the grains show the combined albite-pericline twins. Albite-ala and Albite law are of the largest incidence (53) and (52) respectively. Manebach-Ala and Manebach-Akline are the least (3). Albite-Ala- is more evident in granites (54% of the total) than in gneisses (34% of the total).

The rock types were collected by the author along a traverse from Chinnaponneri to Rangasami Koil on the Western flank of the Yelagiri Hills near Jalarpet Railway station (Long 78° 34′. Lat. 12° 34′).

12 sections were cut from the rocks and 110 felspar grains were determined for anorthite content and twin-laws according to the method of Reinhard (1931). The 2V values determined are compared with the values read from Köhler's Graph (1941-p-41) for the corresponding anorthite percentage. The comparative results are given in Table I. These are in close agreement.

Tertsch has made a distinction between the high and low temperature optics of the felspars and has constructed a stereogram on (010) with the wandering of X, Y and Z ellipsoidal axes for the various anorthite contents. The curves are distinguished as high and low temperature curves. The transferred poles of the ellipsoidal axes of the felspars here determined, when plotted on

TABLE I.

Anorthite percentage and twin laws. *Anorthite percentage of 2V Values*

	Anorthite %	Albite	Pericline*	Albite-Ala	Manebach Ala=akline	Manebach Akline=Ala	Anorthite %	2 V. Values Recorded	2 V. Values of Köhler
Coarse light grey granite ..	15-25	8	5	4	—	—	13	+ 85	+ 85
Light grey granite ..	18-25	8	4	5	—	—	14	+ 86	+ 87
Fine grained grey granite ..	15-25	5	3	11	—	—	15	+ 87	+ 88
Pink Porphyrytic granite ..	15-28	2	—	5	—	—	16	+ 87	+ 89
Pinkish grey granite.	15-20	1	—	4	1	—	17	—	90
Coarse grey granite ..	15-20	3	1	2	—	—	18	− 87	− 89
Pinkish-grey prophyritic granite ..	15-23	5	2	6	—	—	19	− 88	− 87
Pink granite ..	15-25	4	1	3	—	—	20	− 86	− 86
Light grey granite ..	17-25	2	—	5	—	1	21	− 86	− 85
							22	− 86	− 84
		38	16	45			23	− 85	− 84
							24	− 84	− 83
							25	− 82	− 83
							26	− 82	− 82
							27	− 82	− 82
Gneiss ..	15-23	9	4	4			28	− 82	− 83
Amphibolite ..	23-28	5	3	4	2	2			
		52	23	53	3	3			

* Pericline lamellae across the albite law.

this Tertsch stereogram (1942, p. 200, Fig. I) give points on the low temperature curves. The felspars of the granites and gneisses of Jalarpet, therefore, belong to the low temperature series.

FIG. 1. Stereogram after Tertsch (1942. p. 200, Fig. 1).
Optical Orientation of Palagioclases
× and — low temperature optics.
⊙ and .... high temperature optics.

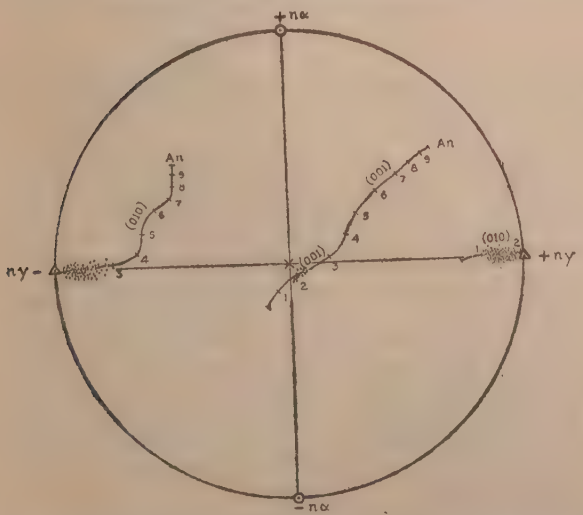

FIG. 2. Fedoroff-Nikitin Stereogram (Plate 2 of Reinhard). Wandering of the composition face with the ellipsoidal axes fixed in position.

A cumulative diagram of the anorthite content is given on plate 2 of Reinhard (Fig. 2) and of the complex laws in plate 5 of Reinhard (Fig. 3)

Fig. 3. Fedoroff-Nikitin Stereogram (Table 5 of Reinhard) Wandering of the twin poles in parallel and complex laws with the ellipsoidal axes fixed in position.

(010) is more common as a twinning plane than (001), and the poles form a band as noted by Manolescu (1934, p. 453).

The Pericline twins occur as fine lamellae across the albite twins. The grains, therefore, show the combined albite-pericline twins. Albite-Ala is the most abundant twin law (53) followed by the albite and pericline (52). Manebach-Ala and Manebach-Akline number 3 each. There are occasional grains of orthoclase.

The paucity of Albite-Ala twins among plutonic rocks for the anorthite content 0-24% has been observed by Gorai (1951, p. 886, Table 2); and Coulson (1932, p. 173-184) remarks that this law is of common incidence at 33% An. The author, however, has recorded that the albite-ala law is prevalent among plutonic rocks between the An % 15-28.

A precise distinction, therefore, between albite-ala and albite law seems very essential. Coulson's check (1932, p. 173-184) and

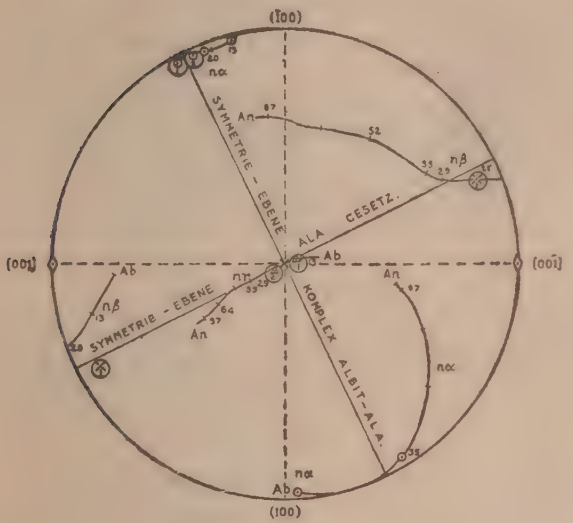

FIG. 4. Position of the transferred ellipsoidal axes for Albite-ala according to Plate 3 of Reinhard for An % 25.

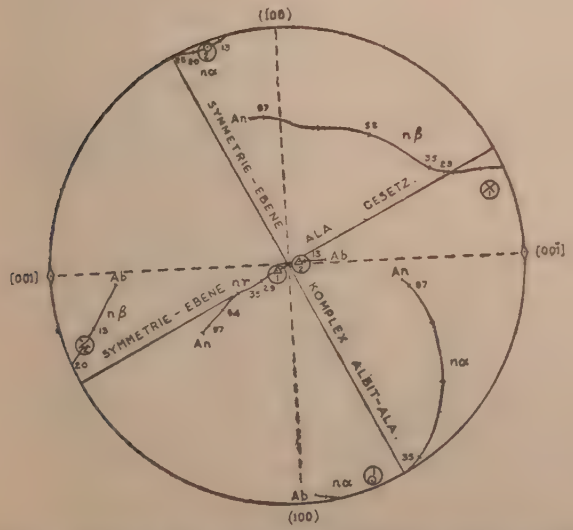

FIG. 5. Position of the transferred ellipsoidal axes for Albite law according to Table 3 of Reinhard for An % 16.

Nikitin's constructions were used to resolve this conflict. Two stereograms are here given which are typical of these laws. In Fig. 4, (Albite-Ala law) beta of the two individuals lie on the same side of the symmetry plane Ala, and alpha and gamma lie on either side of the symmetry plane Albite-ala, and the two individuals are symmetrical with reference to this plane. In Fig. 5 (Albite law), alpha of the two individuals lie on opposite sides of the symmetry plane albite-ala, and beta likewise lie on opposite sides of the symmetry plane Ala. The two individuals are symmetrical on rotation of 180° around the perpendicular to (010).

The author concludes that the albite-ala law is as much characteristic of granites and gneisses as albite and pericline laws. Albite-ala is more evident in granites (54% of the total) than in gneisses, where it is 34% of the total.

The author expresses his grateful thanks to Dr. P. R. J. Naidu for his guidance and constant encouragement.

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Kinetics of the Olefine-Bromine Reaction. (Part IX)

The addition of Bromine to Maleic Acid and Maleic and Citraconic Anhydrides in Acetic Acid Solutions

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ABSTRACT

Preliminary observations on the Thermal addition of Bromine to Maleic Acid and Maleic and Citraconic Anhydrides in Acetic Acid are reported here. The variation of the induction period and the reaction velocity with structure is clearly seen: the induction period as well as the degree of autocatalysis is greater for Maleic Anhydride than for Citraconic Anhydride. The velocity constant is calculated by the equation $k = 1/t \left[\frac{1}{a(a-x)} + \frac{1}{a^2} \log \frac{(x)}{(a-x)} \right]$ Lithium bromide eliminates the period of induction and gives a fair 'bimolecular' constant. The rate of reaction is related to the concentration of the catalyst, the influence of the catalyst tending to a limiting value. The striking difference between the rates of Maleic Acid and the Anhydride is also noted.

In previous parts of this series (Anantakrishnan and Venkataraman, 1941, 1946; Mathai and Anantakrishnan, 1954) the addition reactions of some $\alpha\beta$ olefinic acids were studied in acetic acid as well as in carbon tetrachloride solutions. The reaction has been characterised by varying periods of induction in the absence of a catalyst and the use of a nonpolar solvent showed the need for a polar environment for the initiation of the reaction. While the behaviour of fumaric acid appeared normal, unpublished observations of Venkataraman (private communication) showed that the case of the cis isomer was more complicated. It is well known that, in the case of dibasic acids which readily form anhydrides, glacial acetic acid facilitates such a change and

this may be one of the factors involved in the addition of bromine to maleic acid. It was, therefore, felt necessary to study both this acid and the anhydride and, as a further extension, the influence of an additional methyl group on the reactivity was considered a useful supplementary observation. The present report deals with the preliminary observations.

Experimental

Glacial Acetic acid and Bromine were prepared as in the earlier parts and purity established as before.

Maleic acid was prepared from maleic anhydride supplied by American Cyanamide Corporation and purified by recrystallisation from acetone. m.p. 128·5°.

Maleic Anhydride. The sample from the American Cyanamide Corporation was distilled, the fraction distilling between 196°C and 197°C being collected and further purified by double recrystallisation from pure dry chloroform. The recrystallised sample was stored in a vacuum desiccator. m.p. 54°C.

Citraconic anhydride was prepared by the method of Kekule-Fittig, (Cohen. 1908), by the rapid distillation of citric acid, dried over anhydrous copper sulphate and fractionated, the fraction boiling between 213°C and 214°C being collected.

The lithium bromide used was prepared from a Kahlbaum sample of lithium hydroxide and pure hydrobromic acid.

The reaction was followed by titration of unreacted bromine iodimetrically. The experiments were carried out as in earlier parts in an electrically controlled thermostat at 30·1°C and all access of light was avoided throughout the course of the reaction.

Typical runs of the experiments, both uncatalysed and catalysed, are presented in Tables I and II and the uncatalysed reaction is shown in Figure 1, clearly demonstrating the induction period and the variation of the same with structure.

In all the cases, the reaction has been followed till about 60% of the bromine had reacted and both reactants were kept initially at about the same concentration. While the formation of the acetoxy compound is not excluded in these studies, the reasonable assumption has been made that the extent of reaction is given by the amount of free bromine that has disappeared.

TABLE I

The uncatalysed reaction between bromine and (a) Maleic anhydride, (b) Citraconic anhydride and (c) Maleic acid at 30·1°C

	Concentration of Olefine	Concentration of Bromine
(a)	0·1000 M	0·1009 M
(b)	0·1000 M	0·09954 M
(c)	0·03333 M	0·03343 M

(a)

Time in minutes	0	1074	1248	2144	2700	2946	3586	4086	4216
Titre ml.	15·50	15·30	15·10	14·05	12·75	12·00	9·60	6·95	5·95
% reaction	0	1·29	2·58	9·36	17·74	22·58	38·0	55·17	61·62

(b)

Time in minutes	0	1384	1726	2244	2562	2988	3243	3410	3884	4050
% reaction	0	1·26	3·14	8·80	14·46	24·22	29·56	40·25	52·83	59·83

(c)

Time in minutes	0	388·5	626·2	1123	1336	1885	2520	3163	3495
% reaction	0	3·07	6·70	11·33	16·48	23·71	35·05	48·45	57·73

TABLE II

The reaction between Bromine and the Olefinic acid anhydrides catalysed by Lithium Bromide at 30·1°C.

Concentration of the reactants.

	Olefine	Bromine	Lithium Bromide
(a)	0·1000 M	0·1016 M	0·1129 M
(b)	0·1000 M	0·1006 M	0·06428 M

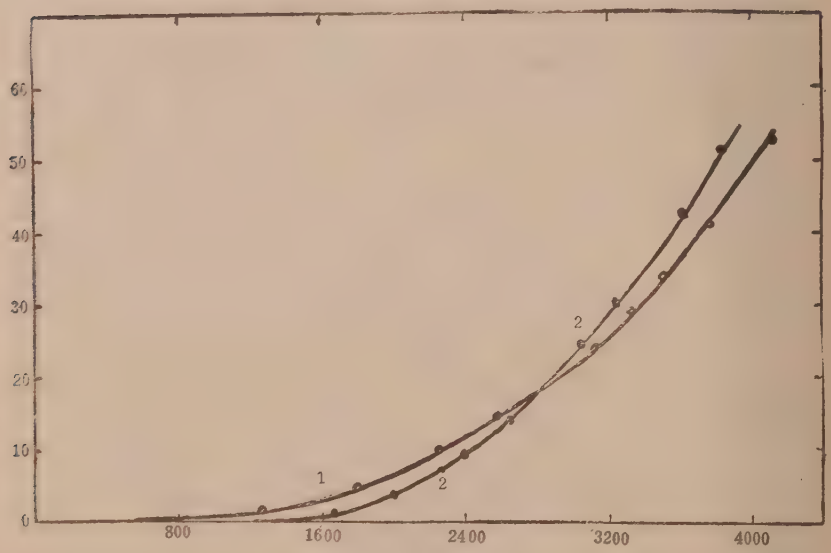
(b)

Time in Minutes	0	31	71	114	404	553	724	1042	1308	1530
% reaction	0	3·30	6·60	9·57	20·71	33·99	41·26	53·14	62·37	66·99

(a)

Time in Minutes	0	40	89	151	216	418	628	920	1168	1370
% reaction	0	5·00	8·75	14·37	20·00	33·75	44·38	57·50	64·69	70·25

(a) and (b) as in Table I.



Reaction between the acid Anhydrides and Bromine.
1. Citraconic Anhydride. 2. Maleic Anhydride.

Discussion of Results

Bromine additions to olefines can be either electrophilic or nucleophilic depending on the structure of the olefine. In the present instances, it is difficult to decide *a priori* which mechanism holds good as there are no electron-sinks in the structure while

there are groups which deactivate the double bond towards electrophilic reagents. The presence of autocatalysis is, however, unmistakable in the uncatalysed reaction. We can represent the course of the reaction by the rate equation of the form.

$$dx/dt = kx(a+bx)^2$$

for both reactants having the same concentration. Taking the value of b to be -1, the integrated form can be represented by

$$k = (1/t)\left[\frac{1}{a(a-x)} + \frac{1}{a^2}\log\, x/(a-x)\right]$$

The results obtained with the two anhydrides are given in Table III below.

TABLE III

Concentration of Olefine and Bromine M/10

Olefine	Rate Constant (moles per litre, minutes^{-1})		
% reaction	10	20	50
Citraconic anhydride ..	0·0606	0·0546	0·0516
Maleic anhydride ..	0·0587	0·0546	0·0529

These values may be contrasted with the values of "Bimolecular" rate constants obtained for the 'uncatalysed' reaction (Table IV).

TABLE IV

	"Bimolecular constants" for % reaction	
	10	20
Citraconic anhydride ..	0·000687	0·00113
Maleic anhydride ..	0·000875	0·00139

An inspection of the tables clearly shows that the reaction with the two compounds studied are catalysed by the product of the reaction. Nozaki and Ogg (1942) had noticed that the addition reaction in acetic acid is catalysed by chloride ions, using Lithium Chloride and Robertson and Coworkers (1948) had confirmed the

same. In the present study, Lithium Bromide has been used. This compound eliminated the induction period and gave a fair constant using the conventional rate equation for a second order reaction (Table V):

TABLE V

Olefine	Concentration.	100 k_2 for % reaction mole/1 min^{-1}		
		5	10	20
Maleic anhydride	0·1 M	1·032	1·100	1·100
Citraconic anhydride	0·1 M	0·907	0·896	0·871

Anantakrishnan and Venkatraman (loc cit) had shown that in the reaction catalysed by hydrogen bromide, the rate of the reaction was related to the concentration of the catalyst, the influence of the catalyst tending to a limiting value. In the initial additions of the catalyst, the rates may be expected to show a simple proportionality. In the present exploratory study, the reaction has been studied only at a single initial concentration of olefine but a comparison of the time required for a given fraction of the reaction at each stage will give some idea of the rate without any assumption as to the mechanism of the catalysis. The results obtained with maleic acid are presented in Table VI below.

TABLE VI

The catalysed reaction between maleic acid and bromine at 30·1°C

Concentration of reactants: 0·033 M.
Catalyst used: Lithium Bromide.

Concentration of Catalyst.	Time for % reaction in minutes.			
	10	19	27·1	34·3
0·4567 M	234	510	855	1050
0·9509 M	127	353	625	810

Allowing for the errors in graphical extrapolations in getting these readings from the actual observations, it will be seen that the effectiveness of the catalyst tends to diminish with increasing proportions and also that the rate is roughly proportional to the initial concentration. Thus without making any tacit assumptions on the mechanism of catalysis, the reaction appears to be of the second order. It is fairly established that the reaction is of the first order with respect to the olefine and this means that the reaction is of the same order with respect to bromine also. A fuller analysis is possible only after further work.

We may now turn to a comparison of the three compounds among themselves. The striking difference between the rates of maleic acid and the anhydride where the pure acid adds on bromine at a rate much higher than the anhydride at even higher concentrations calls for some comment. If the acid underwent any conversion to the anhydride, the apparent result can only be a slowing down. The formation of the anhydride ring causes the pronounced -I-T effect of the carbonyl group to deactivate the double bond towards electrophilic reagents though evidence is as yet inadequate to postulate a nucleophilic initiation of the reaction though the apparent lack of activation by the addition of a methyl group in citraconic anhydride lends support to such a picture. In the case of maleic acid, the dimensions of the atoms and the bonds require that the two carboxyl groups cannot be in the same plane though the four carbon atoms may lie in the same plane. This change would result in a reduction of the deactivating influence of the carboxyl groups and this tendency is further enhanced by the possibility of hydrogen bonding between one hydroxyl and the other carbonyl group. Without postulating a mechanistic change, it is thus possible to account for the sharp differences in the rates noticed for the acid and its anhydride.

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Cutaneous and Pulmonary Exchange of Gases in the Frog *

BY

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ABSTRACT

The respiratory exchange through the skin and lungs in the frog during normal respiration has been estimated. It is found that the skin takes in 0·023037 c.c./gm./hr. of oxygen while the lungs take in 0·17247 c.c. /gm./hr. and the total oxygen requirement is 0·1955 c.c/gm./hr. That the skin takes an active share in respiration is demonstrated when the frog is left in a limited volume of water and the oxygen pressure in the water is decreased gradually. When the frog remains under water for 15 mins. there is a slow reduction in the rate of oxygen intake through the skin. When forced to remain under water for 7 more minutes it is asphyxiated.

Introduction

Spallanzani (1807) was the first to suggest that the adult amphibia respire through the skin as well as the lungs, and the cutaneous respiration of the amphibia has been studied by others *viz.*, Edwards (1824), Regnault and Reiset (1849), Berg (1868), Fubini (1881), Klug (1884), Dissard (1893), Marcacci (1894), Couvreur (1895), Bohr (1899), Krogh (1904a, 1904b, 1941), Pütter (1914) and Camo (1935). However as there is no clear and consistent account of the share taken by the skin in meeting the oxygen needs of the animal, a fresh study was made to assess the respiratory activity of the skin and lungs (1) during normal respiration and (2) when the frog remains under water without breathing air for varying periods of time.

Gaseous exchange through skin and lungs

Two samples of tap water were analysed for their oxygen contents by the Winkler's method, and for their carbon dioxide

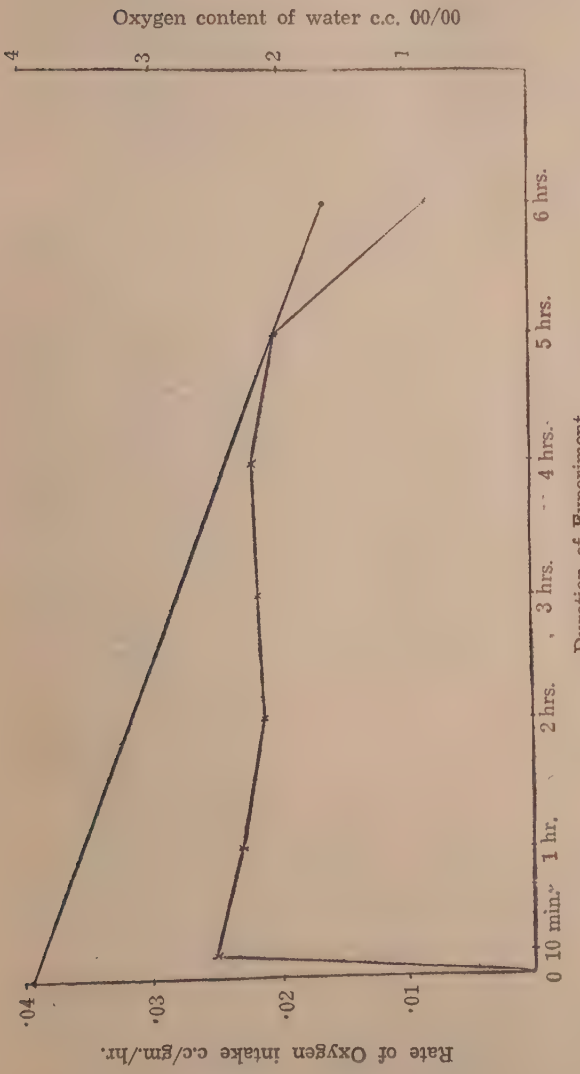
* Part of thesis approved for the degree of Master of Science of the University of Madras.

contents by the method recommended by the Association of Official Agricultural Chemists (1945). It was found to contain 3·948 c.c. of oxygen per litre. A frog *Rana hexadactyla* was left in an open bottle filled with tap water covered with liquid paraffin, and after one hour the water in the bottle was analysed for its gaseous content. The oxygen intake and the carbon dioxide output through the skin were calculated, and reduced to c.c. /gm./hr. This experiment was repeated ten times. On an average it was found that the rate of oxygen intake was 0·023037 c.c. /gm./hr. and carbon dioxide output 0·0101109 c.c. /gm./hr.

To estimate the gaseous exchange through the lungs air freed from carbon dioxide and moisture was passed through the animal chamber containing a frog of known weight, and led through tubes of concentrated sulphuric acid and soda lime weighed before and after the experiment. The gaseous exchange through lungs was calculated according to the method given by Harris, Gilding and Smart (1951, pp. 119-132). This experiment was repeated ten times and on an average the rate of oxygen intake through the lungs was found to be 0·17247 c.c. /gm./hr. and carbon dioxide output 0·082096 c.c /gm./hr.

Thus the ratio of oxygen taken in through the lungs to that taken through the skin is 7·5 : 1. But both put together meet the oxygen requirements of the body, which thus would be 0·1955 c.c. /gm./hr.

During the normal oxygen intake of 0·023037 c.c. /gm./hr. through the skin, the oxygen content of the surrounding water was 3·948 c.c. per litre. To estimate the rate of respiration through the skin when the oxygen pressure of the water decreases to 1·6 c.c. per liter as it does after 6 hours of the frog's remaining in the same bulk of water and given access to air, the oxygen intake through the skin for periods of 10 min., 1 hr. 2 hrs, 3 hrs., 4 hrs., 5 hrs., and 6 hrs., were calculated. It has already been mentioned that at the end of 1 hr the rate of oxygen consumption through skin is 0·023037 c.c. /gm./hr. At the end of 2 hrs the rate averaged round 0·0213274 c.c. /gm./hr. This indicates a slight fall in the rate obviously due to the fall in the oxygen pressure of water by 0·778 c.c. per litre (see text fig. 1). At the end of 4 hrs. the rate of oxygen intake through the skin increases to 0·021921 c.c. /gm./hr. This slight rise in the rate of oxygen intake in the face of a further fall of oxygen pressure in the water by 0·79 c.c.



TEXT FIG. 1. The relationship between the rate of oxygen intake through the skin and oxygen content of water during normal respiration.

per litre is significant of an active effort on the part of the skin to accelerate its activity to meet the oxygen requirements of the body. During the 5th hour the effort is not sustained and the rate of oxygen intake falls to 0·020429 c.c./gm./hr. After 5 hrs. the oxygen content in the water further decreases from 2 to 1·6 c.c. per litre, and the activity of the skin becomes weakened. As a consequence the oxygen intake through the skin decreases to 0·00808 c.c. /gm/hr. The above figures are averages of ten repetitions of the experiment.

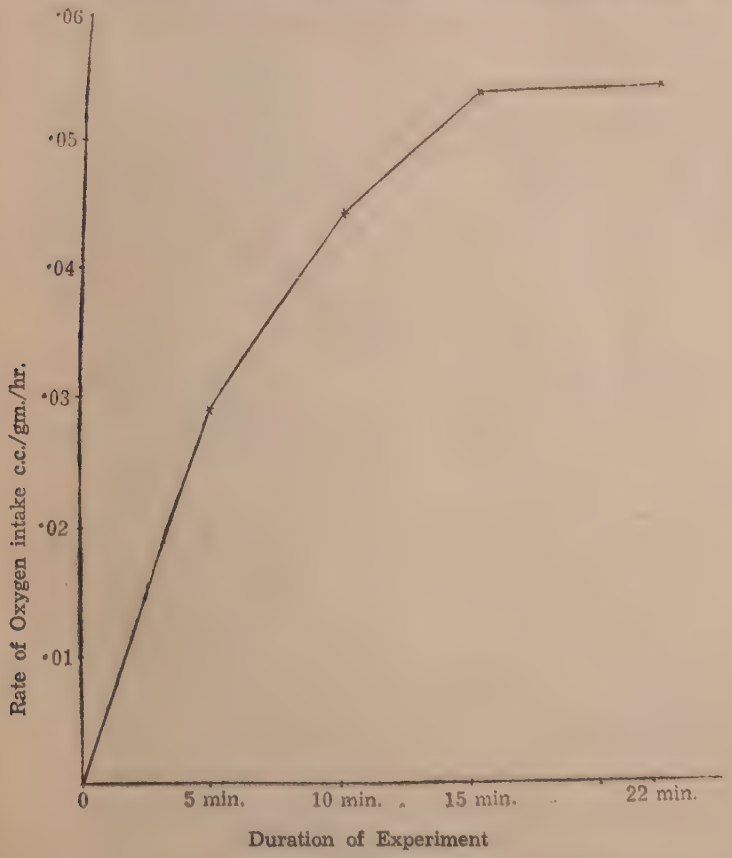
Gaseous exchange through the skin alone, when denied access to air

In order to estimate the oxygen intake and carbon dioxide output through the skin in a frog which remains under water for varying periods of time, the frog was left in a jar full of water covered with liquid paraffin, and when the frog succeeded to remain under water for 5 minutes the water that was analysed showed an oxygen content of 3·873 c.c. per litre, and the rate of oxygen intake through the skin when calculated was 0·029169 c.c. /gm/hr. Similar estimations were made when the frog succeeded to remain under water for 10 mins., and 15 mins. The averages of several results of each are tabulated below. It would be clear from text fig. 2. that the rate of oxygen intake through the skin in the second

Rate of oxygen intake through skin of frogs remaining under water.

Duration of expt. in mins.	Wt. of frog in gms.	Oxygen content of water before expt. c.c. per litre	Oxygen content of water after expt. c.c. per litre.	Oxygen removed from water c.c. per litre.	Rate of oxygen intake through the skin c.c. gm./hr.
5	17·108	3·9447	3·873	0·0717	0·029169
10	17·558	3·9265	3·6976	0·2289	0·04460
15	20·07	3·947	3·4695	0·4775	0·054005
22·3	46·35	3·954	3·442	0·512	0·0550

period of 5 mins. is lesser than the first period of 5 mins. by 0·015431 c.c./gm/hr. while in the third period of 5 mins. it records a further fall by 0·009405 c.c./gm/hr. As none of the frogs tried in this experiment ever remained under water for more than 15 mins. it may be concluded that the amount of oxygen taken in through the skin is not sufficient, and that respiration through the



Text Fig. 2. Oxygen intake through skin when the frog is denied access to air.

lungs becomes necessary. This experiment affords indirect evidence to show that the activity of the skin is not stepped up as seen in text fig. 1 because during the short period the oxygen pressure in the water did not decrease sufficiently low as to stimulate the skin to increased activity.

To estimate the oxygen intake through the skin when the frog was compelled to remain under water after 15 mins., a frog was introduced into a jar of 1850 c.c. capacity filled with water, and the mouth of the jar was closed with a cork. The results of thirty repetitions of the experiment showed that on an average the frog was asphyxiated in 22·3 mins., and the water when analysed showed a decrease in the oxygen content by 0·512 c.c. per litre and an increase in the carbon dixoide content by 1·8055 c.c. per litre. The rate of oxygen intake through the skin before asphyxiation i.e., at the end of 22 mins., was 0·0550 c.c. /gm/hr. (see text fig. 2). It would be clear that beyond 15 mins. for a further period of 7 mins. after which the frog is asphyxiated the skin takes in only 0·0010 c.c. /gm/hr. of oxygen. The oxygen taken in through the skin becomes totally insufficient to meet the oxygen needs of the animal, and death by asphyxiation ensues.

Discussion.

Marcacci (1894) considered that the skin served only in the elimination of carbon dioxide while Bohr (1899) found that carbon dioxide was more easily eliminated through the skin than the oxygen was absorbed. This was supported by Klug (1884) and later by Krogh (1904a) who says "the skin and lungs have, in the frogs shared between themselves the respiratory functions, so that carbonic acid is chiefly eliminated through the skin, while oxygen is absorbed through the lungs." In order to estimate the respiratory exchange through the skin, Edwards (1824), Regnault and Reiset (1849) Berg (1868) Fubini (1881) and Marcacci (1894) performed the experiments after extirpating the lungs without envisaging the abnormal conditions introduced by such an operation. The results presented in this paper indicate that out of a total oxygen requirement of 0·1955 c.c. /gm/hr. a greater proportion of the respiratory needs of the frog is met by the lungs, than by the skin i.e., in the ratio 7·5 : 1. They are both significant in the oxygen intake and carbon dioxide output during normal respiration.

That the skin plays an active part in respiration is clearly demonstrated when the frog is left in a limited volume of water and the oxygen pressure in the water is decreased gradually by 2·348 c.c. per litre in 6 hrs. As explained earlier during the 3rd and 4th hours the rate of oxygen intake through the skin records a

slight rise even though the oxygen pressure in the water decreases by 0·79 c.c. per litre. Thus the skin is able to augment its efforts to meet the respiratory demands of the body, thereby confirming that the part played by the skin is of an active character involving physiological effort.

When the frog remains under water for 15 mins. the oxygen intake through the skin is 0·054005 c.c. /gm./hr. whereas the amount of oxygen needed is 0·1955 c.c. /gm./hr. Therefore it appears that beyond the rate of 0·1415 c.c. /gm./hr. the frog must resort to the use of the lungs. The oxygen reserve in the body can be calculated from this rate viz. 0·1415 c.c. /gh/hr. When the frog is forced to remain under water for a further period of 7 mins. and the supply of oxygen from the lungs is cut off, the oxygen debt increases to a level till it becomes fatal to the animal. Therefore during this period of 7 mins. the frog must have depleted the oxygen reserve in the body. For a frog weighing 45 gms. the oxygen intake through the lungs for one hour is 0·17247 c.c. /gm./wt., and for 22·3 mins. it is approximately 0·0641 c.c./gm./wt. Thus some of the phenomena as aspnoea, dyspnoea and asphyxiation familiar to us in human respiration are found already initiated in the amphibian level.

Acknowledgments

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Dedifferentiation in the Colony of *Polyclinum indicum* Sebastian

BY

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ABSTRACT

Colonies of *Polyclinum indicum* Sebastian of various sizes ranging from ¼" to 1¾" broad were kept in a limited volume of sea water without giving any change, and observations were made. Adverse conditions like shortage of food and oxygen induced regression of the thorax and abdomen. and the post-abdomen formed a bud. Recovery is possible only if the colonies are changed to fresh sea water after five days, otherwise even in the sea regressed colonies die. Only the buds which detach from the abdomen are able to redifferentiate under normal conditions, and zooids as a whole develop to keep up the survival of the colony. The decay of the test affects the whole colony, and healthy life is possible as long as the zooids are able to secrete fresh test to repair the loss due to the decay during regression.

Introduction

The effects of adverse environmental factors on ascidians have been studied by Driesch ('02), Schaxel ('14), Huxley ('25) and Riess ('37) in *Clavelina lepadiformis,* and by Huxley ('26) in *Perophora viridis, Amaroucium pellucidum* var. *constellatum,* and *Botryllus,* and described as constituting the phenomenon of regression or dedifferentiation. In all these cases regression of tissues is followed by resorption of various degrees and finally, if normal environment is restored, the individuals are reorganised from the remaining parts. The present paper deals with the process of dedifferentiation in the common Madras ascidian, *Polyclinum indicum* (Sebastian '54). While the process of regression and reorganisation in *P. indicum* is in a way similar to the process undergone during asexual reproduction or budding, the latter process is described briefly before the experiments in dedifferentiation are dealt

with. (The full details of asexual budding will be described elsewhere). Here, the process of dedifferentiation dealt with is only of the zooids within a whole colony and not of isolated pieces. The phenomena of regression and dedifferentiation were studied by following the changes in gross and microscopic structure of colonies kept in laboratory troughs.

The colonies were collected from the rocky coast of Royapuram, north of Madras harbour. They were obtained in sufficient numbers, and for experimental purposes colonies of various sizes ranging from ¼" to 1¾" broad were used. In the study of redifferentiation under natural conditions, colonies with regressed zooids were kept immersed in wire guaze cages among the stones of Royapuram coast.

Asexual reproduction in P. indicum

Asexual reproduction in *P. indicum* is the typical post-abdominal budding as observed in the Polyclinids like *Amaroucium proliferum* (Kowalewsky '74), *Sydnium turbinatum* (Brien '37) and various forms by Berrill ('35, '50). The post abdomen at the time of budding elongates to 2½ to 3 times the length of the thorax and abdomen put together, and the nutritional trophocyte cells enter into it from the region of the thorax. After this the thorax and abdomen regress and autolyse, and the post-abdomen is isolated. The anterior third of the post-abdomen swells and at the posterior border of this region the epidermis constricts and finally cuts through the epicardium thus isolating the anterior bud. The middle third of the post-abdomen also swells and brakes away due to epidermal strobilation, thus setting free the middle and posterior buds. The three buds are similar except in the nature of gonads. Typically, a bud has an outer ectodermal covering and inner epicardium both of parental origin, the trophocytes filling the space in between the two. But the gonad in the anterior bud loses its shape and disappears. In the middle bud a part of the gonad remains unchanged, while in the posterior bud the gonad does not undergo regression and resorption. In the reorganisation of buds, the epidermis gives rise to the future epidermal covering of the blastozzoid, while the epicardium gives rise to the pharynx intestine, heart, nervous system and gonads. While this typical condition happens in the anterior bud, in the middle and posterior buds the gonad arises by proliferation of the existing portion of the gonad.

The sexual zooids freshly brought undergo asexual budding after two weeks, and the first generation of buds redifferentiates in another two weeks. The temperature of the sea at Madras is 27-29°C.

Dedifferentiation in P. indicum

Colonies of *P. indicum* were collected from the shore and kept under observation in a large trough of sea water for about three days. From this lot individual colonies were taken and each was placed in a finger-bowl of water collected from the Chepauk area of

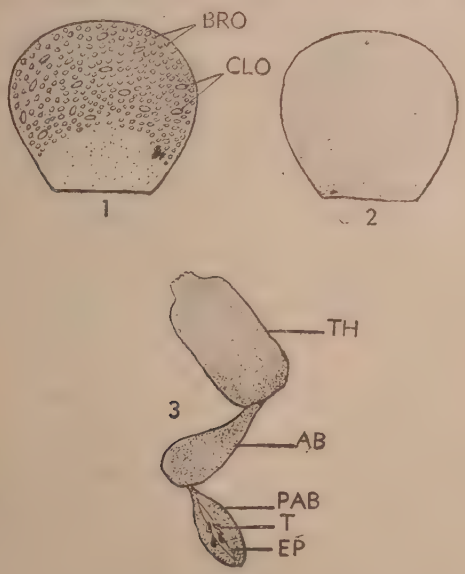

Fig. 1. A colony of *P. indicum* showing branchial and cloacal openings on the surface.

Fig. 2. The same colony after regression, showing the smooth outer surface.

Fig. 3. A regressed zooid where the post-abdomen has become a bud, but attached to the abdomen. AB, *Abdomen;* BRO, *Branchial openings;* CLO, *Cloacal openings;* EP, *Epicardium;* PAB, *Post-abdomen;* T, *Testis;* TH, *Thorax.*

Madras coast. After about 48 hours the groups of external apertures on the colony disappeared (Fig. 1 & 2) and therefore the systems of zooids could not be observed on the surface. The dis-

appearance of external apertures is due to the retraction of the thoracic region, a condition indicative of the onset of asexual reproduction. Sectioning of the thorax of an individual zooid showed partial autolysis. The post-abdomen showed an opaqueness due to the wandering in of trophocyte cells from the thoracic region. On the fifth day the post-abdomen became oval like a bud, the thorax and abdomen undergoing resorption. Thus a single bud was formed in a short time instead of three buds formed in about twenty-one days during the typical asexual reproduction under normal conditions. The ovary degenerates in the post-abdomen, while the testes remained unchanged as sperm vesicles. This can be compared to the posterior bud formed during the normal asexual reproduction, or the single bud that is formed in dwarfed zooids of normal colonies. The formation of separate buds detached from the parent described above is not the rule, because in many zooids buds remain attached (Fig. 3). On an analysis, it is found that twenty to thirty per cent of the zooids have the buds completely severed from the anterior regions and seventy to eighty per cent have the buds retaining their connections with the abdomen. About the sixth day, the test of the colonies became yellow and assumed an unhealthy look prognostic of the death and decay which followed later.

Redifferentiation in P. indicum

(a) *In a trough of sea water inside the laboratory.* If the dedifferentiated colony of *P. indicum* is transferred to a container with fresh sea water, before the test is affected as described above, the test is retained in the colony, and the buds are reorganised into blastozooids and definite patterns appear on the surface. The patterns, however, are not continuous as before, but in scattered patches, interrupted by areas without patterns. This is because the zooids are formed only from the buds which have severed connections from the abdomen, while those which remain attached to the abdomen undergo no further development.

The recovery of the colony depends on the former type of buds being larger in number than those of the latter type of buds which do not develop. If the buds which do not develop are more in number, the test begins to show signs of decay in two to three days in these areas. In colonies where such decaying areas are extensive even the small patches containing active zooids are affected through the spread of the decay of the test. This is seen

more often in full-grown colonies of large size, but not in smaller ones with fewer zooid systems. In these small colonies the zooids are relatively younger, and the proportionately small decayed areas do not affect the colony adversely. Table 1 gives the size of the colony, the approximate number of zooid systems, the total number of zooids which survive and effect recovery of the colony.

TABLE I

Size of colony	No. of colonies observed	Approx. No. of		Total No. of zooid systems redifferentiated and active	No. of zooids in each.	Final fats of colony.
		Zooid systems in each.	Zooids in each.			
¼" Broad	62	3-4	30-100	3-4	30-40	Survived
½" „	59	5-6	120-200	4-5	40-50	„
¾" „	50	5-7	150-250	4-6	40-60	„
1" „	64	6-8	250-300	3-4	40-60	„
1½" „	55	9-11	280-350	4-5	50-70	Decayed
1¾" „	50	10-13	300-400	5-6	60-80	„

The table above shows that smaller colonies survive better than larger ones. Of the 105 colonies exceeding 1" breadth none survived, while all 235 colonies smaller than this size survived. Secondly, it will be seen that the number of zooid systems redifferentiated and active is proportionately far greater in the small-sized colonies than in the large ones. In a colony ¼" broad all the 3-4 zooid systems remain active. In a colony four times larger, out of 6-8 zooid systems only half the number are active being separated wider areas of inactive zooids. In a colony seven times as large, out of 10-13 systems only 5-6 retain their activity, increasing the intervening inactive areas. In such colonies the chances of recovery are thus reduced. Thirdly, the reduction in the number of active zooids is greater in larger colonies than in the smaller ones. Out of a total of 750 zooids in all the colonies ranging from ¼" to 1" in breadth, 230 remain active, while in the

colonies 1½″ and 1¾″ broad, only 150 remain active out of a total of 750 zooids. It is probable that a large number of zooids of larger colonies became aged and senescent and are not able to recover after regression.

As the colony grows larger and fresh zooids are added, fresh test is formed. But in the older parts of the colony the test remains as before. In those areas the test is susceptible to decay. Once decay sets in, it affects the inactive zooids which remain in the test and later it may also spread to active zooids as well. Thus the normal healthy period of life of a colony is as long as that of the whole test, and the accidental mutilations the test may sustain are rapidly repaired, only if the proportion of the young zooids in full possession of the secretory capacities, is sufficiently high in relation to the magnitude of the damage which has to be repaired.

(b) *Keeping colonies in natural habitat.* In order to study redifferentiation of the colony in the natural environment, colonies which had dedifferentiated in the laboratory troughs, were kept in wire guaze cages fastened to the rocks found along the coast in the Royapuram area where *P. indicum* occurs. As the results tabulated in Table II show, there is a slight increase in the proportion of the number of newly formed zooids, over the numbers indicated in previous table.

TABLE II

Size of colony.	No. of colonies observed.	Approx. No. of		Total No. of zooid systems redifferentiated and active	No. of zooids in each.	Final fate of colony.
		Zooid systems in each.	Zooids in each.			
¼″ Broad	50	3-4	90-100	3-4	35-50	Survived
½″ „	49	4-6	120-200	4-5	45-60	„
¾″ „	58	4-7	100-250	4-5	40-70	„
1″ „	57	5-8	210-290	4-5	50-80	„
1½″ „	55	9-10	260-330	4-6	60-90	Decayed
1¾″ „	46	10-12	300-490	5-7	70-100	„

Out of the 820 zooids belonging to colonies 1½″ and 1¾″ broad, 190 remain active, i.e., 23 per cent whereas in the laboratory tanks only 20 per cent were active. The number of active zooids being larger when the colony was transferred back to the sea than fresh change of sea water in the laboratory, is due to the fact that in the latter case sea water from opposite the laboratory was used. This is deficient in oxygen when compared to the sea water in the natural environment. It may be mentioned here that as Royapuram, where ascidians occur, is over four miles away, it was difficult to bring sea water from this locality to the laboratory, and as the sea-shore near the laboratory is sandy, cages could not be left in the sea.

Discussion

The process of dedifferentiation shows variation in different ascidians. In *Clavelina* (Driesch '02; Huxley '26) the zooid undergoes reduction, and becomes a spheroidal mass, the various organs undergoing autolysis in varying degrees. In *Perophora* (Huxley '21) dedifferentiation takes place either as in *Clavelina,* the zooids reducing to a spheroidal mass, or by reduction followed by total resorption into the stolon. In *Amaroucium* (Huxley '21) a third type of dedifferentiation is found in the formation of post-abdominal buds characteristic of Polyclinids, preceded by the regression of the thorax as in *Clavelina.* But, in redifferentiation any single zooid is not able to maintain the revival of the colony, but a group of zooids as a whole is able to function in such a way as to keep up the survival of the colony. Huxley maintains that the competition between the parent and bud for nutrition palys the important role in the activity of one or the other; when the parent is well fed buds are suppressed, and conversly, when the parent is starved it regresses and buds take the upper hand. A similar phenomenon is found in *Botryllus* and *Botrylloides* (Berrill 41 a & b, & 47). In both *Botryllus* and *Perophora* regression and resorption are in the antero-posterior gradient.

In *P. indicum* the process of dedifferentiation takes place in an adverse environment like shortage of food, lac of oxygen etc., as in the forms described above, and the regression takes place in an antero-posterior gradient. As in the Polyclinid *Amaroucium* (Huxley '21) *P. indicum* shows bud formation after regression of the anterior regions. Here also, only those buds which are free

are able to reorganise into complete zooids after five days of dedifferentiation. In the final reorganisation of the colony as a whole, individual zooids are unable to play any part as zooids as a group.

Even though Huxley ('21) does not speak anything special about the role of the test in the survival of the colony in *Amaroucium*, in *P. indicum* it is found that decay in any part of the test spreads to the zooids as well, thus bringing about their death and decay. This may be the reason why younger colonies survive better on account of their capacity to secrete fresh test and repair the loss, as against the older ones which are unable to recover after any injury.

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A Report of the Analysis of Responses to the Personality Inventory of Boys From Low Socio-Economic Families

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ABSTRACT

An analysis of the responses to the Personality Inventory from 220 boys from low socio-economic families was done with a view to find out the relation between the gross unfavourable score and factors such as puberty, father's occupational status, 'broken-home' conditions, birth order, total number of children in the family and community—forward-backward-Harijans, etc. It was found that there was significant difference between mean scores of subjects who were found to have attained puberty and those who have not. It is inferred, therefore, that puberty is accompanied by emotional instability. Other facts—father's occupation, 'broken home' conditions, birth order, total number of children in the family and community —were not found to be important from the point of view of emotional instability.

This paper just indicates where the controversial problem of 'Adolescent emotional instability' actually lies.

In an earlier investigation (Shanmugam, 1953) the responses to the Personality Inventory from 275 boys from low-socio economic families were studied according to their (chronological) age groups. It was found at the age of fifteen emotional instability was greater as compared with other age groups—12-18. In this paper, variables such as puberty, father's occupation, broken-home conditions, community of the subject, birth order, and total number of children in the family were considered in relation to the gross score of the Personality Inventory. Out of 275 boys studied earlier, only 220 boys were used in this investigation. Data regarding variables cited above could be obtained only from 220 subjects.

Brief account of Methods used:

The methods used for collecting data for this paper are interview, questionnaire and consultation of the school records. Wher-

ever it was necessary, teachers and parents of the boys were also interviewed. For data regarding pubertal status of the subjects in addition to the direct interview of the subjects, the opinion of the medical officer who examined these subjects were taken into account.

Results:

Classification of the Personality Inventory Score according to the pubertal status of the subjects.

In the table below distribution of the scores of the Personality Inventory of subjects who have attained puberty and who have not is given to find out whether there is any difference in the scores of these two groups.

TABLE 1

Showing the distribution of the scores of subjects who have not attained puberty and those who have attained puberty.

Score		Subjects	
		Attained Puberty	Not Attained Puberty
65	..	1	..
60	..	1	2
55	..	5	3
50	..	12	4
45	..	14	6
40	..	21	13
35	..	17	12
30	..	17	15
25	..	15	14
20	..	11	15
15	..	6	7
10	..	3	5
5	..	1	..
Total	..	124	96
Mean	..	36·4585	32·7295
S. D.	..	11·655	11·902
S. E.	..	1·0466	1·216
Mean Difference	..	1·6023	
Critical Ratio	..	2·413	Significant*

* For many psychological experiments, 0·05 level of probability is considered stringent enough. In this paper also for significance at 0·05 level of probability only is considered.

There is a difference between the mean scores of these two groups; the mean score of the pubescent group being higher. The critical ratio 2.413 is significant at 0.05 level of probability. From this, it may be inferred pubescence has relationship with the emotional instability of the individuals.

Classification of the scores of personality inventory according to the interval between the present age of the subjects and the age at which the subjects attained puberty.

Since it is known from the preceding classification that puberty is related to emotional instability, an attempt is made to find out whether puberty affects the emotional instability immediately after the onset of puberty or after one or two years of interval. For this 124 boys who were found to have attained puberty were used.

TABLE 2

Showing distribution of scores according to the interval between the present age and the age of attainment of puberty.

Scores.	Below 1 year.	1 year.	2 years.	3 years.	4 years and above.
65	..	1	..	..	..
60	..	1	..	..	..
55	1	1	1	1	1
50	5	4	1	1	1
45	3	6	2	..	3
40	7	6	3	2	3
35	6	4	2	1	4
30	4	5	3	4	1
25	1	2	2	5	5
20	2	3	5	..	1
15	2	1	..	2	1
10	1	1	..	..	1
5	..	..	..	..	1
Total	32	35	19	16	22
Mean	33·845	39·43	34·895	32·25	32·045
S. D.	12·073	12·67	10·794	11·10	12·58
S. E.	2·31	2·18	2·54	2·84	2·75

TABLE 3

Showing significance of difference between the means given in Table 2.

	Mean Difference	$\sqrt{\sigma\bar{D}_1^2 + \sigma\bar{D}_2^2}$	Critical Ratio.	Significance.
Below 1 year and 1 year ..	2·487	3·176	0·782	No.
Below 1 year and 2 years ..	1·95	3·433	0·568	No.
Below 1 year and 3 years ..	4·595	3·684	1·247	No.
Below 1 year and 4 years ..	2·800	2·591	1·080	No.
1 year and 2 years ..	4·535	3·347	1·354	No.
1 year and 3 years ..	7·18	3·604	1·992	No.
1 year and 4 years ..	5·385	3·587	1·501	No.
2 years and 3 years ..	2·645	3·832	0·690	No.
2 years and 4 years and above ..	0·850	2·743	0·221	No.
3 years and 4 years and above ..	1·795	3·974	0·451	No.

From the table above, it may be seen that interval between the present age and the age of attainment of puberty does not affect scores on the Personality Inventory. Probably by examining samples of subjects with longer intervals between the attainment of puberty and their present age may throw some light on this problem.

TABLE 4

Showing the Distribution of Personality Inventory Scores according to the subjects' Fathers' Occupation.

Scores.	Profession. Highly skilled.	Skilled.	Semi-skilled.	Unskilled.
65	1	..	..	..
60	..	..	2	1
55	1	3	3	1
50	5	6	3	2
45	6	5	7	2
40	10	9	12	3
35	8	8	11	2
30	5	11	15	1
25	9	8	10	2
20	7	10	6	3
15	3	6	2	2
10	4	2	1	1
5	..	..	..	1
Total	59	68	72	21
Mean	34·54	33·92	35·25	34·385
S. D.	11·99	11·88	10·70	15·16
S. E.	1·560	1·639	1·261	3·357

TABLE 5

Showing significance of difference in Mean Scores in Table 4.

Profession.	Mean Difference.	$\sqrt{\sigma D_1^2 + \sigma D_2^2}$	Critical Ratio.	Significance.
Highly skilled and skilled ..	0·630	2·262	0·278	No.
Highly skilled and semi-skilled ..	0·705	2·006	0·351	No.
Highly skilled and unskilled ..	0·160	3·701	0·04	No.
Skilled and semi-skilled ..	1·085	2·067	0·521	No.
Skilled and unskilled	0·47	3·785	0·125	No.
Semi-skilled and unskilled ..	0·865	3·584	0·241	No.

The tables above show that the differences in mean scores of groups according to father's professions are not significant. Therefore, it may be considered that profession of the father do not influence the emotional instability of the present subjects.

TABLE 6

Showing Personality Inventory Scores in relation to .the 'Broken home' conditions of the subjects.

Score.	HOME CONDITIONS *		
	Father Dead.	Mother Dead.	Both Parents Alive.
65 ..	..	..	1
60 ..	..	1	2
55 ..	1	2	5
50 ..	2	3	11
45 ..	3	4	13
40 ..	5	5	23
35 ..	2	1	26
30 ..	2	6	23
25 ..	2	3	24
20 ..	2	3	20
15 ..	1	1	10
10 ..	..	1	7
5 ..	..	..	1
Total ..	20	30	166
Mean ..	38·75	37·83	33·825
S. D. ..	11·21	12·585	13·174
S. E. ..	2·52	2·299	1·022

* The number of individuals both of whose parents were dead were too few to be considered here. Again, few subjects had step-mothers to allow any quantitative treatment. Therefore these two categories are omitted.

The term 'broken home' is used to denote 'loss of parents by death only' Divorce is not so common in South Indian Society, as it is in the West.

TABLE 7

Showing the significance of the difference between the Mean Scores in Table 6.

Subjects Home Conditions.	Mean Difference.	$\sqrt{\sigma D_1^2+D_2^2}$	Critical Ratio.	Significance.
Father dead and mother dead	0·92	3·411	0·269	No.
Father dead and both parents alive ..	4·935	2·719	1·815	No.
Mother dead and both parents alive ..	4·015	3·719	1·079	No.

The table shows that though so much emphasis is laid on the 'broken home' condition and its influence on the emotional stability of the individuals, in the present subjects, it has not revealed its importance. The differences between the means of subjects whose parents (mother and father) were dead and the subjects whose parents were alive are not significant.

Personality Inventory Scores and the Birth Order of the Subjects.

Classification of the scores of the subjects according to their birth order was done with the view to find out whether birth order affects the score on the Personality Inventory.

TABLE 8

Showing the distribution of Personality Inventory Scores according to subjects' birth order.

Birth order Score.	Only child.	First child.	Second Child.	Third child.	Fourth child.	Fifth child.
65	..	..	..	..	..	1
60	..	..	1	..	..	2
55	..	1	1	2	..	4
50	1	5	4	4	2	..
45	1	5	5	5	4	..
40	2	4	8	10	6	4
35	1	6	9	5	2	6
30	..	11	10	6	2	3
25	2	7	7	6	4	3
20	1	6	7	2	4	6
15	..	2	3	3	1	4
10	1	2	2	..	2	1
5	..	1	..	..	..	..
Total	9*	50	57	43	27	34
Mean	..	33·60	34·55	37·47	34·44	35·24
S. D	..	11·89	11·28	10·63	12·15	15·04
S. E.	..	1·679	1·49	1·62	2·964	2·618

* Number of subjects under the category 'only child' is only nine. Therefore it is not considered in this investigation.

TABLE 9

Showing Critical Ratio for Table 8.

Birth order.	Mean Difference.	$\sqrt{D_1^2 + D_2^2}$	Critical Ratio.	Significance
First and Second ..	0·95	2·224	0·423	No.
First and Third ..	3·865	2·354	1·641	No.
First and Fourth ..	0·84	3·406	0·246	No.
First and Fifth ..	1·64	2·656	0·167	No.
Second and Third ..	2·915	2·201	1·324	No.
Second and Fourth ..	0·11	3·317	0·033	No.
Second and Fifth ..	1·75	2·54	0·688	No.
Third and Fourth ..	3·025	3·377	0·895	No.
Third and Fifth ..	2·225	2·619	0·849	No.
Fourth and Fifth ..	0·80	3·608	0·221	No.

The table above reveals that birth order of the subjects does not affect the scores in the Personality Inventory. As such 'birth order' of the subjects is not an important factor in the present case.

Number of children in the family and the Personality Inventory Scores of the subjects.

Classification of the scores on the Personality Inventory was done with the view to see whether the number of children in the family affects the scores on the Personality Inventory of the subjects.

TABLE 10

Showing the distribution of Personality Inventory Scores according to the number of children in the family.

Score.	No. of children. 1 to 2.	3.	4	5.	6.	7 and above.
65	..	..	..	..	..	1
60	..	1	..	1	1	..
55	1	1	1	1	3	1
50	3	7	3	2	..	1
45	2	4	6	4	..	4
40	7	5	10	1	5	6
35	5	3	5	5	4	7
30	9	4	10	5	1	3
25	6	6	7	3	5	2
20	3	4	3	6	5	5
15	1	2	2	2	4	2
10	2	1	1	2	1	1
5	..	..	..	1	..	..
Total	39	38	48	33	29	33
Mean	34·44	37·265	35·855	32·584	32·69	39·795
S. D.	11·15	12·719	10·115	13·47	15·125	12·125
S. E.	2·126	2·091	1·46	2·381	2·858	2·178

TABLE 11

Showing Critical Ratio for Table 10.

No. of children.	Mean Difference.	$\sqrt{D_1^2 + D_2^2}$	Critical Ratio.	Significance.
1-2 and 3 ..	2·825	2·981	0·947	No.
1-2 and 4 ..	1·41	2·578	0·546	No.
1-2 and 5 ..	1·85	3·191	0·579	No.
1-2 and 6 ..	1·75	3·561	0·491	No.
1-2 and 7 ..	1·355	3·043	0·445	No.
3 and 4 ..	1·41	3·168	1·477	No.
3 and 5 ..	4·681	2·551	0·552	No.
3 and 6 ..	4·575	3·541	1·292	No.
3 and 7 ..	1·47	3·019	0·487	No.
4 and 5 ..	3·271	2·793	1·171	No.
4 and 6 ..	3·165	3·209	0·986	No.
4 and 7 ..	0·06	2·622	0·022	No.
5 and 6 ..	0·106	3·719	0·028	No.
5 and 7 ..	3·211	3·226	0·995	No.
6 and 7 ..	3·105	3·593	0·864	No.

As may be seen from the above table there is no relation between the total number of children in the family and scores in the Personality Inventory in the present subjects.

Classification of the Personality Inventory Scores according to the communities of the subjects:

TABLE 12

Showing distribution of the Scores according to communities of the subjects.

Communities Score.	HINDU			Other Religions Christians, Muslims, Jains, etc.
	Forward.	Backward.	Harijans.	
65	..	1	..	..
60	2	..	1	1
55	3	4	..	1
50	10	3	2	1
45	7	8	4	1
40	14	11	5	4
35	11	12	3	3
30	9	10	5	8
25	15	7	4	3
20	11	8	2	5
15	4	2	4	3
10	3	4	..	1
5	..	..	1	..
Total	89	70	31	30
Mean	35·71	36·00	36·452	31·50
S. D.	12·105	12·435	12·700	11·715
S. E.	1·283	1·486	2·318	2·175

TABLE 13

Showing the Critical Ratio for Table 12.

Communities.	Mean Difference.	$\sqrt{\sigma D_1^2 + \sigma D_2^2}$	Critical Ratio.	Significance.
Forward and Backward ..	0·290	1·959	0·148	No.
Forward and Harijan ..	0·752	2·65	0·283	No.
Forward and other communities ..	4·210	2·526	1·666	No.
Backward and Harijan ..	0·452	2·753	0·164	No.
Backward and other communities ..	4·510	2·632	1·711	No.
Harijan and other communities ..	4·900	3·176	1·542	No.

The communities of the subjects have no effect on the Personality Inventory score, since the differences between the mean scores of the subjects from different community groups are not significant.

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Carbonisation Assay of South Arcot Lignite at Different Temperatures

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ABSTRACT

The proximate analysis of a sample of South Arcot Lignite was done and its calorific value determined. The low temperature carbonisation assay of the lignite was performed at different temperatures and the effects of the temperature and the rate of attainment of the temperature on yield of the products have been studied. The proximate analysis of the char obtained at different temperatures and determinations of its calorific value were carried out. The calorific value of the gas has also been obtained. Certain interesting conclusions have been drawn with regard to the influence of temperature on the yields of the products.

Introduction

South Arcot lignite has been very much in the news since the systematic investigation of the deposits was undertaken by the Geological Survey of India, about 10 years back. Extending over an area of 100 sq. miles with a thickness of bed varying between 13 ft. and 90 ft., the deposits are estimated to be about 2000 million tons. As a preliminary to the commercial exploitation of the deposits, the Government is conducting a pilot scheme of excavation involving open cut mining to expose an area of 100 ft. square at the surface of the bed. This pilot scheme is expected to yield data which would form the basis for judging the commercial feasibility of the project. Compared to bituminous coal, lignite is indeed a poor grade fuel. Nevertheless under the conditions prevailing in South India with no coal mines in its immediate neighbourhood, lignite is expected to provide a sufficiently cheap and good industrial fuel for this area. Further the proposed setting up of a high power thermal station at the minehead itself will, not only augment our

power resources, but will also ensure a steady and reliable supply of electricity independent of the vagaries of the monsoons. Besides these obvious uses, lignite can also be put to a variety of other uses in which numerous products of considerable industrial value can be derived from lignite by suitably processing it. Some of these methods of processing of lignite and utilisation of the products obtained have been under investigation in these laboratories for over a year. Lignite, like coal, can be subjected to low temperature carbonisation and the solid product, lignite char, can be used as a smokeless domestic fuel, of high calorific value. The tar obtained in the above process, is itself a good liquid fuel; it can also be distilled to yield various grades of fuel oils besides products such as wood preservatives, waxes and pitch. Hydrogenation of the tar is another process which could yield better grades of liquid fuels. Extraction of lignite with various solvents yields montan wax, a product of good commercial value. Hydrogenation of lignite either by the German Bergius process or the American process using fluidization technique to yield petroleum hydrocarbons, will be a fruitful line of investigation in our country also.

The present paper deals principally with the results obtained on subjecting lignite to low temperature carbonisation under various conditions. A sample of about 1 cwt. of lignite from the lignite mines at Neyveli, was received for investigations. The proximate analysis of the sample was made in the first instance and was followed by a detailed study of the products obtained by low temperature carbonisation assay. A note on the results of this work has been published (Subrahmanyan and Madhavan Nair, 1954).

Experimental Procedure:

A representative sample of the air-dried lignite was ground in a ball mill and the -80 mesh powder was taken for carrying out the various tests. The standard methods (Himus) were strictly followed in carrying out the proximate analysis of the lignite. Since the lignite had a high percentage of volatile matter the modified method of determination (A.S.T.M., D-271) was used. In this method a weighed amount of the lignite powder was initially heated over a low Bunsen flame for 10 minutes to expel part of the volatiles and then kept at the standard temperature of 950°C in an electrically heated muffle furnace for exactly

6 minutes. The difference in weight is reported as the volatile matter. The sulphur content was estimated as barium sulphate by heating 1 gram of the lignite powder with A. R. Eschka mixture ($MgO + Na_2CO_3$) and converting it into sulphate. The calorific value of the moisture-free (dried at 105-110°C) lignite was determined in a Berthelot-Mahler oxygen Bomb Calorimeter. Table I gives the results.

TABLE 1

Proximate Analysis.

	Air-dry basis as received.	Moisture free basis.
1. Moisture ..	15·7%	—
2. Volatile matter ..	48·8%	57·9%
3. Ash ..	3·28%	3·89%
4. Fixed carbon (by difference)	32·2%	38·21%
5. Sulphur (Eschka method) ..	0·78%	0·93%
6. Nitrogen ..	0·523%	0·62%
7. Calorific value ..	9350 Btu/lb.	11090 Btu/lb.

Low temperature carbonisation assays were performed on the sample of lignite, ground (-80 mesh) and rendered moisture free by drying to constant weight at 105 - 110°C. Experiments were conducted in a Gray-King low temperature carbonisation assay apparatus using an electrically heated and controlled tube-furnace for heating the sample. Since the quality and the quantity of the products of carbonisation are dependent on the type of carbonisation equipment and the method used, the standard procedure and precautions laid down were strictly adhered to, so that the results may form a basis for comparison. The temperature was controlled accurately with the help of Temcometer input controller, which automatically ensured a control of ± 5°C.

After the retort was charged with a weighed amount (20 gms.) of moisture-free lignite, the furnace which was initially brought

to a temperature of 300°C was slid in position over the retort to heat the sample. The rate of heating was adjusted so that the required temperature of carbonisation was reached during the course of one hour. The tar and liquor distilled over were collected in a water-cooled condenser, and the gas, scrubbed free of ammonia with dilute sulphuric acid, was collected at constant pressure over a 1 : 1 glycerine-water mixture. The heating was continued at the carbonisation temperature for nearly 2 hours by which period the gas evolution became negligible. The volume of gas collected was noted, by measuring the volume of the glycerine-water mixture displaced. The weight of tar and liquor collected in the condenser was noted as also the volume of the liquor. The weight of char was obtained from the final weight of the contents of the retort. Tar sticking to the retort tube was determined by dissolving it out in toluene followed by acetone and finding the loss in weight of the retort. This was added to the weight of tar in the condenser to give the total weight of tar distilled over. The ammonia absorbed by the sulphuric acid in the scrubber and that present in the condensed liquor were estimated together by steam distilling the ammonia in a Micro-Kjeldahl distillation apparatus. The carbonisation assay was carried out at various temperatures from 500°C to 750°C. The results are given in Table II.

The proximate analyses of the chars obtained at various temperatures were also performed, the results of which are given in Table III. Since the volatile matter in the chars was very low, a drop of benzene was added to the char before placing it in the furnace at 950°C for estimating the volatile matter — a necessary precaution to ensure an inert atmosphere over the char while heating.

The calorific value of the gas obtained on carbonisation at 600°C was determined in a Jones-Miller Gas Calorimeter. In this apparatus a definite known volume (347 c.c.) of the gas taken in its gas holder, is burnt with an excess of oxygen. The combustion was started and maintained by a steady high tension spark striking at the tip of the burner. The heat liberated was measured by noting the temperature rise of the water in the calorimeter, as usual. The value obtained was 222 CHU per cu. ft. (N.T.P.)—the mean of four independent determinations which showed a maximum deviation of less than 2%

TABLE II.

Low Temperature Carbonisation Assay.

Yields of Products at various temperatures.

Temp. °C	Per 100 gm. moisture-free lignite.					Per ton of moisture-free lignite.				
	Char. gm.	Tar. gm.	Liquor cc=gm	Gas (Amm. free c.c. at 29° C.	Ammonia gm. as $(NH_4)_2SO_4$	Char. lb.	Tar gallon	Liquor gallon	Gas (Amm. free cu. ft. (NTP)	$(NH_4)_2SO_4$ lb.
500	58·6	10·2	10	16000	0·0222	1312	24·35	22·4	5190	3·96
550	50·0	12·0	10	20000	—	1120	28·6	22·4	6480	—
600	48·8	13·9	10·5	23320	0·0243	1093	33·15	23·6	7560	4·24
650	48·3	14·4	10	25300	—	1081	34·35	22·4	8200	—
700	47·2	14·7	11	25200	0·466	1057	35·0	24·7	8170	8·11
750	47·3	15·0	11	26900	—	1062	35·8	24·7	8750	—

TABLE III

Proximate Analysis of Char.

Temp. of carbonisation.	Air dry basis.				Moisture free basis.			
	Moist. %	V.M. %	Ash %	Fixed Carb. by dif. %	V.M. %	Ash %	Fixed C. by diff. %	Cal. value Btu/lb.
500	4·7	21·2	5·3	68·8	22·3	5·6	72·1	14800
600	4·8	8·4	5·1	81·8	8·8	6·0	85·2	14110
700	6·0	5·4	7·3	81·3	5·7	7·8	86·5	13920

A study of the properties of the Low Temperature Lignite Tar obtained on carbonisation at 600°C has just been completed and will form the subject matter of the next paper.

Discussion of Results:

The South Arcot Lignite is found to have a high percentage of volatile matter and low ash and sulphur contents compared with other lignites (Wilson and Wells).

The graph in Fig. 1 correlates the relative amounts of the products of carbonisation with temperature. As is to be expected, the yield of char decreases while the quantities of gas, tar and ammonia distilled over show an increase with increase of temperature. This variation in the quantities of several products is most marked in the temperature range 500°C - 600°C. This observation emphasises the need for an accurate temperature control in this region, if reproducible results are to be obtained. Also from the nature of the curves it may be inferred that at temperatures above the range investigated the percentage yield of char tends to become constant while the volume of the gas may still be increasing.

It was observed during the experiments that the distillation of inherent moisture in the lignite was complete before the temperature reached 350°C. The distillation of tar starts only at about 420°C and is almost over at about 580°C. It was found that the time taken to bring the retort to the final carbonisation temperature has to be accurately controlled because the yields of different

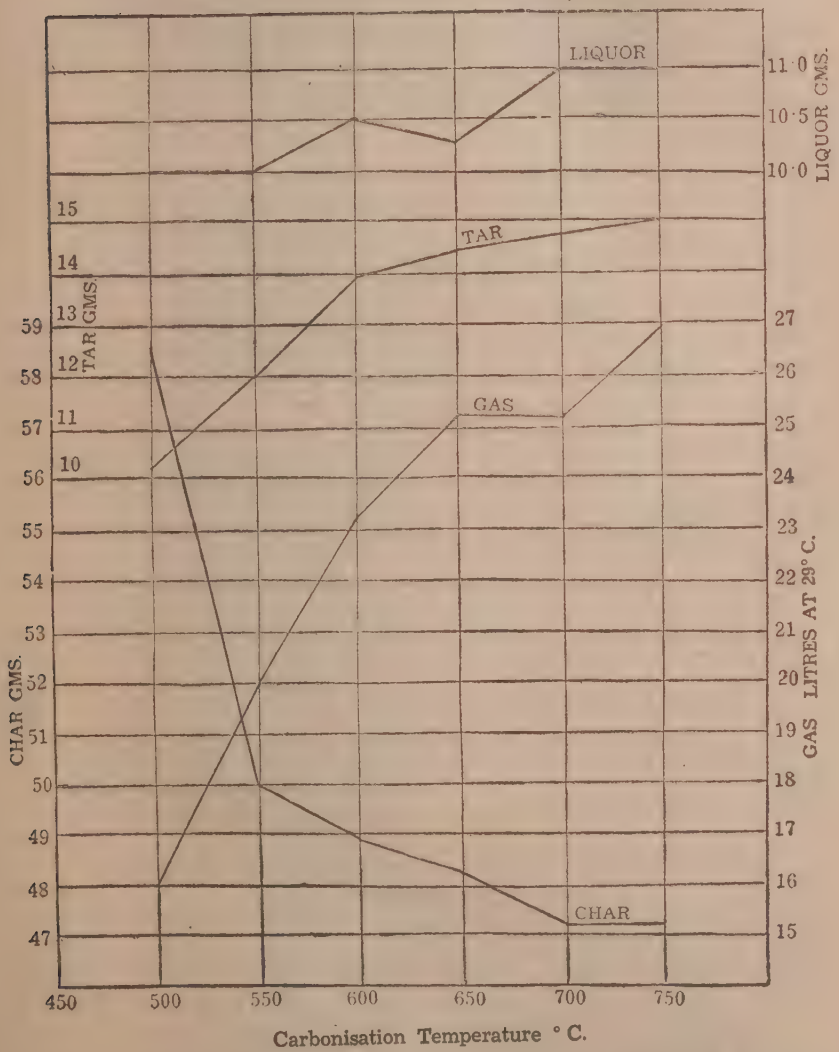

Fig. 1. Yield of Products on Carbonisation of 100 gms. of Moisture-Free Lignite.

products depend on this factor also. The quantity of the gas generated was found to increase with quicker heating, especially in the temperature range 450° - 600°C, presumably because the tar which would have distilled undecomposed got cracked as the final temperature was reached more rapidly.

Lignites yield a high percentage of tar compared to coal, and our sample is by no means an exception to this rule. The tar could be either burnt as fuel, hydrogenated to yield liquid fuels or distilled to obtain several grades of oils. The char has a high calorific value but being very friable, it cannot be handled conveniently unless it is briquetted with tar or other suitable binders.

Ammonia recoverable from the lignite on carbonisation is somewhat low, but increases appreciably at higher temperatures. It is an established fact that high yields of ammonia are not obtained on low temperature carbonisation.

The calorific value of the gas obtained at 600° is rather low. This may, at first sight, appear to be surprising in view of the high volatile content of lignite. The low calorific value can, however, be explained by the fact that lignites being comparatively rich in oxygen, give a gas on distillation that contains a much higher percentage of carbon dioxide and carbon monoxide than low temperature coal gas which has a high hydrocarbon content.

ACKNOWLEDGEMENT

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A Study of the Characteristics of the Low Temperature Tar obtained from South Arcot Lignite

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ABSTRACT

A complete study of the low temperature tar obtained from lignite at 600° C has been made. Besides a determination of the physical characteristics of the tar, the work comprises distillation of the tar into several fractions, alkali-extraction of the phenols followed by the fractionations of the phenols and of the washed oil, determination of the quantities of the distillates, estimation of naphthalene, anthracene, pure phenol and pyridine bases.

The results of a study of the yields of the various products obtained on low temperature carbonisation of South Arcot Lignite at several temperatures form the subject matter of the previous paper (J. Madras Univ., 24 : 385-92). As the lignite gave an appreciable yield of tar on carbonisation, a study of the characteristics of the tar and the products obtainable from it, was undertaken as a fruitful line of investigation.

This paper deals with the characteristics of the tar obtained by the low temperature carbonisation of the lignite at 600°C with special regard to the complete distillation of the tar at atmospheric pressure. Various partially rectified products have been obtained.

As a large amount of tar was required for the complete analysis, the carbonisation was conducted in a locally fabricated retort. The retort was made out of 9″ long, 2″ G.I. pipe, closed at one end. It was mounted in the vertical position during carbonisation and the gases and tar evolved were led into the condenser through a ⅜″ G.I. pipe connected to the top of the retort by a suitable reducing joint. The retort was charged with about ½ lb. of moisture-

free lignite powder (—80 mesh) and heated to the required temperature of 600°C by means of an electrically heated thermostatically controlled crucible furnace. The tar was condensed with water at room temperature. The rate of heating was adjusted so that the final carbonisation temperature was reached at the end of an hour and the temperature was controlled accurately to ±5°C. The tar obtained in the several batches were heated to a temperature not exceeding 50°C and mixed together in the molten condition. And from this stock, samples were taken for conducting the various tests.

Experimental:

The general physical characteristics of the tar were tested adopting closely the methods devised for testing the Asphalts and allied products (Abraham, 1945). The mean results are given in Table 1.

TABLE 1

Characteristics of lignite tar.

No.	Estimation of	Method followed	Result	No. of determinations
1.	Specific gravity	Specific gravity bottle method.	0·931	4
2.	Fusing point	Kraemer and Sarnow method.	31·5° C	4
3.	Volatile matter	At 260° C for 5 hrs.	36·5%	3
4.	Fixed carbon	Residue on heating at 950° C for 7 minutes.	1·25%	4
5.	Ash	Ignition to constant wt.	0·34%	4
6.	Moisture	Dean & Starke method.	10%	2
7.	Solubility in toluol		97·4%	2
8.	Free Carbon (insoluble in toluol)	Computed.	2·6%	2
9.	Solubility in CS_2		99·35%	2
10.	Solubility in CCL_4		97·8%	2
11.	Carbenes (soluble in CS_2 & insoluble in CCl_4)	Computed.	1·6%	2
12.	Solubility in petroleum naphtha		95·2%	2

The main object of the present investigation was to study the behaviour of the tar on distillation. A full analysis of the crude tar was made according to the methods specified by the standardisation of tar products tests committee. The chart in Table 2 (pages 400-401) gives a scheme of the procedure adopted.

A sample of the tar (225 cc.) dehydrated by distillation was used for fractionation. The fractional distillation was carried out in a pyrex distillation flask, heating being done continuously in a bath of molten Wood's Metal so as to avoid local superheating. Five fractions were collected up to the pitching point.

The fractions obtained by the primary distillation were separately extracted with 10% NaOH solution and the reduction in volume noted. The alkali extracts were separated from the 'washed oil', mixed together, boiled, neutralised with dilute H_2SO_4 and again boiled. The liberated 'Tar Acids' or the 'Wet Crude Phenols' containing all the phenolic bodies present in the tar, was fractionated collecting five fractions from 197°C to 240°C. The amount of pure phenol, i.e., C_6H_5OH, present in the fraction (i) up to 197°C, and possibly in the fraction (ii) 197°/205°C, was determined by the following procedure. The pure phenol was isolated by redistilling the fractions (i) and (ii) upto 197° C. To a known amount of this distillate a weighed quantity of phenol C.P. was added. The crystallising points of the phenol C.P. and of the mixture were determined. From this their purities could be estimated by referring to Tables (S.T.P.T.C.) and hence the amount of pure phenol in the distillate calculated.

'The washed oils' were also added together and redistilled in a pyrex fractionating column to collect four fractions up to 300°C. The fraction A' up to 195°C was washed with sulphuric acid and the acid extract steam distilled with excess alkali. The distilled pyridine bases were absorbed in a known excess of acid and by titrating the acid left over, the amount of crude pyridine bases were determined.

Attempts were made to isolate naphthalene, if present, from the fractions B' & C' of the washed oil distillation. There was no crystallisation of any solid even after cooling the fractions to 15°C and seeding them with pure naphthalene. So it was concluded that naphthalene is absent in these fractions. If any anthracene is present in the tar, it will crystallise out on cooling the residue

E′, to 15°C. But in the present case it was found that the residue E′, was semisolid in consistency even at room temperature. This is due to the presence of appreciable quantities of paraffin wax, which is a characteristic feature of low temperature lignite tar (Lowry, 1945). A definite amount of the residue E′ was cooled to 15°C and the solids pressed out of the 'Heavy Paraffin Oil' between folds of filter paper. 'Crude Paraffin Wax' was found to be present in the residue to the extent of a little more than 70% which works out to about 13% of the total dehydrated tar. This 'crude paraffin wax' was tested for any anthracene it may contain, by oxidising it with chromic acid, converting the anthracene to anthraquinone and estimating the anthracene from the weight of anthraquinone. It was found that the crude paraffin wax contained only a very small fraction of anthracene, less than 0·1% of the crude wax. Abraham (1945) also reports little or negligible quantities of napthalene and anthracene in Low Temperature Lignite Tar.

The results of the tar analysis are given in Tables 3, 4, 5 & 6. The Table 7 gives the amounts of partially rectified products recoverable from this tar. The fusion points (Kraemer & Sarnow) of the pitches were also determined.

TABLE 3.

Primary distillation of lignite tar (dehydrated)
Sp. gr. of dehydrated tar 0·931

Fractions	Boiling range.	Volume %	Cumulative %	Specific gravity.
A	Up to 200° C	20·2	20·2	0·934
B	200°/235° C	8·8	29·0	0·931
C	235°/270° C	14·1	43·1	0·930
D	270°/300° C	17·3	60·4	0·925
E	300°/320° C (stop point)	9·3	69·7	0·912
F	Residue (pitch)	26·0		

Fusing point (Kraemer and Sarnow) of the pitch (F), 81° C.

TABLE 4.

Alkali Extraction.

Fraction	'Washed Oil' % volume	'Alkali Extract' % by difference.
A	68·8	31·2
B	83·0	17·0
C	83·4	16·6
D	85·5	14·5
E	92·0	8·0
Total	80·7%	19·3%

'Washed Oil' 80·7% by volume.

'Alkali extract' or 'Wet crude phenols' 19·3% by volume.

TABLE 5.

Analysis of 'Wet crude phenols'. Moisture in wet crude phenols 13·1% by volume.

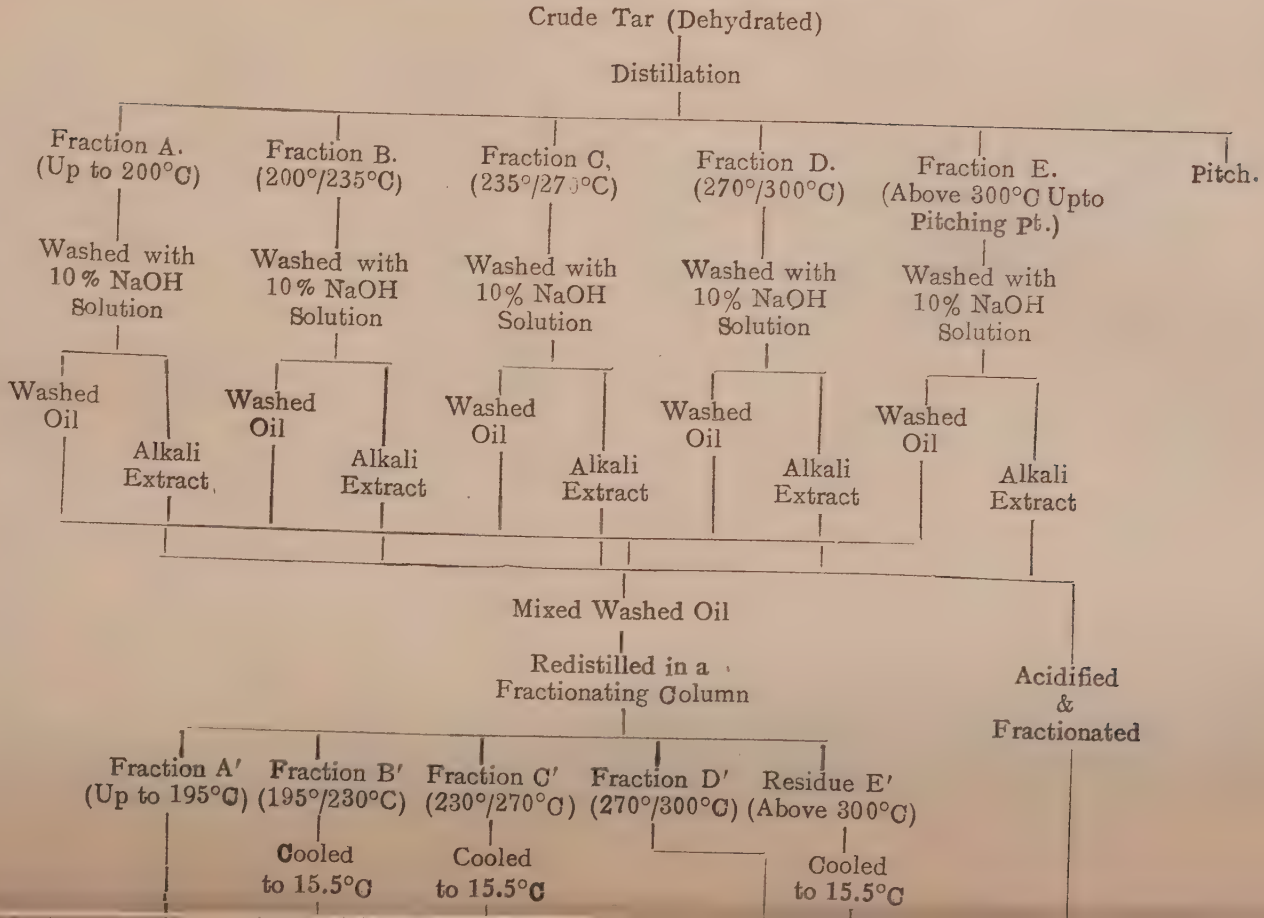
Fraction.	Boiling range	Distillate % by weight.
(i)	Upto 197° C (stop point)	5·6
(ii)	197°/205° C	5·8
(iii)	205°/212° C	3·3
(iv)	212°/220° C	4·2
(v)	220°/240° C (pitching point)	18·0
(vi)	Residue (pitch)	46·6
Losses	——	16·5

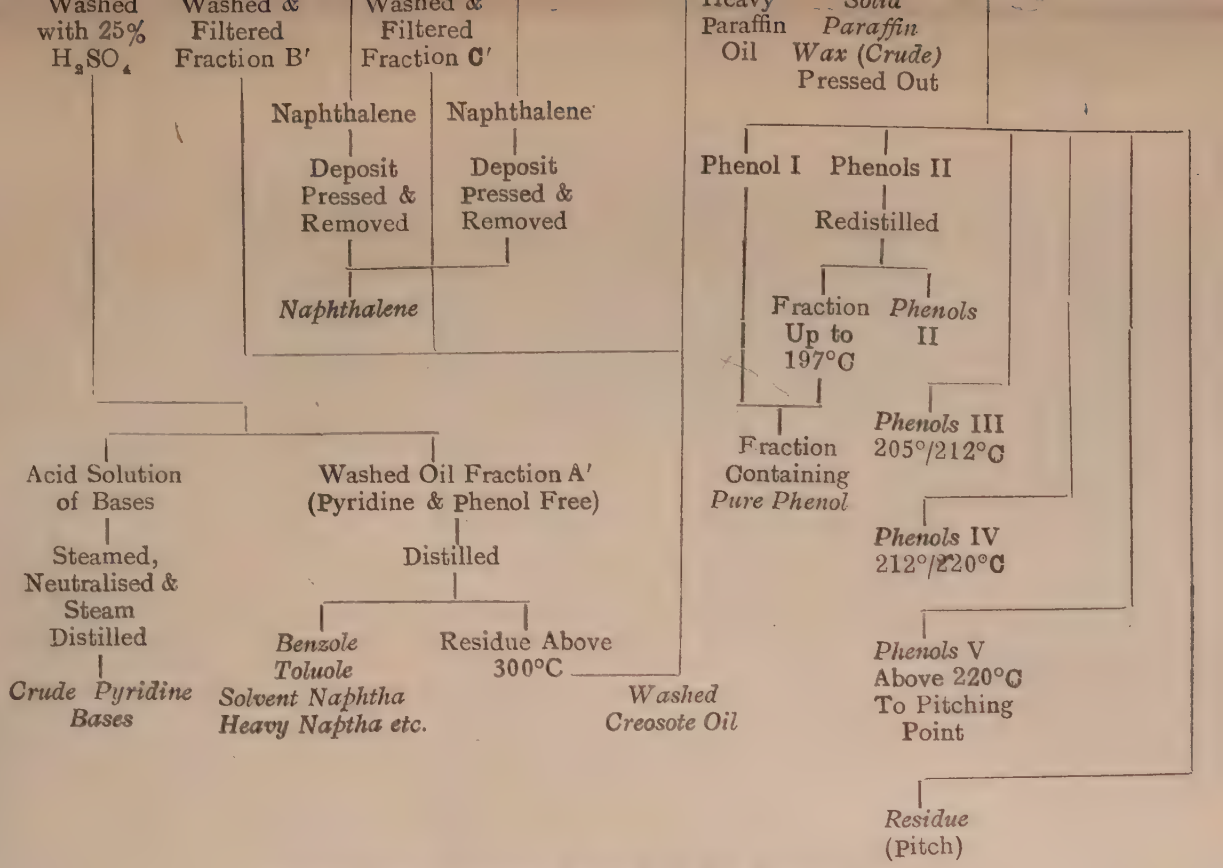
Pure phenol in wet crude phenols, 1·82% by weight.

Fusion point (Kraemer & Sarnow) of the tar acids pitch, 54° C.

TABLE 2

Scheme Followed for the Analysis of Lignite Tar.





Adapted from Standard Methods of Tar Testing, p-79.

TABLE 6.

Fractionation of 'Washed Oil'.

Fraction.	Boiling range.	Distillate % by weight.
A'	Upto 195° C (stop point)	5·8
B'	195°/230° C	7·9
C'	230°/270° C	9·4
D'	270°/300° C (stop point)	22·9
E'	Residue above 300° C	45·6
Losses	——	8·4

TABLE 7.

Partially rectified products from crude dehydrated lignite tar.

	Percentage on dehydrated sample.	Per ton of dehydrated tar.
	% by wt.	
Over 320° C on primary distillation (sp. gr. 0·927) ..	69·3	167·4 gall.
Pitch (K. & S. fusion Pt., 81° C) ..	26·0	582·0 lb.
Loss on acid washing of primary distillates, (wet crude phenols) ..	% by weight 19·3	43·2 gall.
Phenols fractions :—	% by wt.	
(i) ..	0·698	15·61 lb.
(ii) ..	0·752	15·85 lb.
(iii) ..	0·429	9·62 lb.
(iv) ..	0·500	11·20 lb.
(v) ..	2·31	43·0 lb.
(vi) Tar acid pitch (K. & S.) fusion Pt., 54° C) ..	6·01	134·4 lb.
Pure phenol ..	0·011	0·25 lb.
Crude Pyridine bases ..	0·022	0·50 lb.
Benzol, Toluol, Solvent naphtha, Heavy naphtha — Upto 190° C (Mean sp. gr. 0·934) ..	2·37	5·68 gall.
Washed creosote oil (sp. gr. 0·928) ..	22·55	10·85 gall.
Solid paraffin wax, crude ..	14	313·5 lb.

Discussion of Results:

Ratnam and Veeraraghavan (1954) report a much lower percentage of the distillate than we are getting on the primary distillation of the tar, their residual pitch being nearly twice what we got. It may be mentioned in this connection that in our experiments, charring was minimised by a careful control of the rate of heating during the distillation and this fact must have been responsible for the much higher percentage of distillate obtained by us. The 'Tar Acids' indicated by the volume of 'Alkali Extracts' is quite appreciable, although the amount of pure phenol in it is quite small. The large amount of phenolics is explained by the fact that lignite contains a high percentage of oxygen, being a coal of a lower rank.

Since the tar was obtained by low temperature carbonisation, the amounts of naphthalene and anthracene in it are found to be negligibly small. It has been investigated and established that naphthalene and anthracene are formed during carbonisation only at higher temperatures above 700°C and again decompose as the temperature of carbonisation is increased above 1100°C (Lowry, 1945). A typical set of characteristics given by Abraham (1945) also confirm the absence of anthracene and napthalene in low temperature lignite tar.

The tar on distillation provides a good amount of pitch that could be made use of as a binder for briquetting the char obtained on carbonisation.

To summarise, the products that can be obtained, on distillation of the lignite tar are paraffin wax, creosote oil, light oils, higher phenols and pitch in large quantities and a small quantity of pyridine bases.

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J. Madras Univ., B, XXIV, No. 3, pages 405-420, 1954

Some Properties of a Simple Stochastic Model with Time-Trending Coefficients

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ABSTRACT

Though the linear autoregressive schemes have been introduced to provide suitable models for the study of time-series, it is often felt that, in practical applications, these are not flexible enough to represent adequately the observed time-series. It is considered that these schemes will be more appropriate if the constant coefficients are replaced by those that depend on time. To study the effects of time-trending coefficients on the structure of these schemes, some properties of the simplest model in discrete time given by $X(t) = a(t)X(t-1) + \varepsilon(t)$ where ε's form a completely independent system of random disturbances, are discussed in this paper. Starting with the formal solution of the general scheme $X(t) = \sum_{r=1}^{k} a_r(t)X(t-r) + \varepsilon(t)$, the solution of the simple scheme is given and the properties of its correlogram are studied. It is also shown that the variates $S_n(t) = \sum_{r=1}^{n} X(t-r)$, obtained by taking partial sums of $X(t)$ tend to normality as n tends to infinity in the standard measure under certain conditions. The correlogram of the scheme $S_n(t)$ is obtained and compared with the correlogram of the simple model. As a practical illustration, the suitability of this scheme as an economic model for family budget data is discussed in the last section of the paper.

I. *Introduction*

The need for providing suitable specification for the study of time-series has led to the concept of autoregressive schemes that take a random element into the structure of the models. These schemes, the linear form of which is particularly developed for the analysis of stationary time-series, form a class of the general theory of stochastic processes that specify mathematical models with a random element in their set-up to suit various phenomena, taking the recorded observations as a realisation of the specified process.

Though the autoregressive models provide a more realistic approach to the analysis of time-series than the classical methods and have been used in recent studies[1] to represent different phenomena arising in Economics and in other branches of knowledge, their specification imposes the serious restriction of stationarity on the original series. In practical situations, particularly in the field of Economics, it is not possible to justify this assumption, since no economic system yet observed has been stationary over long periods. Further, Kendall (1953), after a detailed analysis of a variety of economic time-series, observed that it is difficult to separate the trend element from the fluctuations in observational series. These causes are considered responsible for the failure of autoregressive models to provide adequate representation of observational series in certain practical situations. For such time-series, it is felt that appropriate models can be obtained by replacing the constant coefficients of the linear autoregressive schemes by those that depend on time and thus relax the condition of stationarity.

While the effects of the use of time-trending coefficients on the correlogram of second order scheme in continuous time has been studied by Hartley (1952), Kendall (1953) applied certain forms of the second order schemes in discrete time to represent observed economic time-series. But so far no systematic treatment of these schemes is available. Since most observational phenomena are recorded as discrete series, some properties of the linear autoregressive schemes with time-trending coefficients in discrete time have been discussed in this paper, taking the simple form of the Markov type as the basis of study.

II. *Specification of the Scheme*

Keeping in view the form of the linear autoregressive schemes in discrete time, the corresponding model of the k^{th} order with time-trending coefficients can be written as

$$X(t) = \sum_{r=1}^{k} a_r(t) \, . \, X(t-r) + \varepsilon(t) \qquad .. \quad (1)$$

where t, time, takes all positive integer values and ε's are random disturbances that are at least orthogonal.

1. Number of references can be cited where autoregressive schemes have been applied. Some of them are noted in references 3, 5, 6 and 10.

Given k initial conditions $y(i)$, i taking the values 1 to k, such that

$$y(i) = \mathrm{X}(i) - \sum_{r=1}^{i-1} a_r(i)\, \mathrm{X}(i-r)$$

following Andre's method, the solution for the scheme can be written as

$$\mathrm{X}(t) = \begin{vmatrix} \varepsilon(t) & -a_1(t) & -a_2(t) & \dots & -a_{k-1}(t) & -a_k(t) \\ \varepsilon(t-1) & 1 & -a_1(t-1) & \dots & -a_{k-2}(t-1) & -a_{k-1}(t-1) \\ \dots & \dots & \dots & \dots & \dots & \dots \\ \varepsilon(k+1) & 0 & 0 & \dots & \dots & \dots \\ y(k) & 0 & 0 & \dots & \dots & -a_{t-2k}(k) \\ y(2) & 0 & 0 & \dots & 1 & -a_1(2) \\ y(1) & 0 & 0 & \dots & 0 & 1 \end{vmatrix}$$

On simplification of the determinant this result can be reduced to the form

$$\mathrm{X}(t) = \sum' \sum \Big[\prod_{r=1}^{i} a_{k_r}\Big(t - \sum_{r=1}^{i-1} k_r\Big)\Big]\varepsilon(t-m)$$

where $\sum_{r=1}^{i} k_r = m$, the summation extending over every partition of the number m into repetitions and permutations the sign of each term can be determined from the ε's of the determinant.

From the general scheme given in equation (1), the simplest linear model with time-trending coefficients can be written as

$$\mathrm{X}(t) = a(t)\, \mathrm{X}(t-1) + \varepsilon(t). \qquad \dots \quad (2)$$

This is a modified form of the Markov scheme with the solution

$$\mathrm{X}(t) = \sum_{r=1}^{\infty} \Big[\prod_{i=1}^{r} a(t-i)\Big]\varepsilon(t-r) \qquad \dots \quad (3)$$

if the process has started long time back. To retain the fluctuations of the scheme finite, the right hand side of the above equation must be made almost everywhere convergent. The necessary and sufficient condition to satisfy this requirement is that (see Bohman (1949))

$$\sum_{r=1}^{\infty} \prod_{i=1}^{r} a^2(t-i) < \infty \qquad \dots \quad (4)$$

Since $\prod_{i=1}^{r} a(t-i)$ is a continued product, writing $a(t-i) = a_0 + a'f(t-i)$ where a_0 and a' are constants, it can be seen from the theory of convergence that $\sum_{r=1}^{\infty} \prod_{i=1}^{r} a^2(t-i)$ is convergent if

$$\sum_{i=1}^{\infty} [a^2(t-i) - a_0^2] < \infty \qquad \ldots \quad (5)$$

and $\qquad |a_0| < 1$

If $f(i)$ takes the simple form $1/i$, $\sum_{i=1}^{\infty} [a^2(t-i) - a_0^2]$ can be written, for a fixed t, as $\sum_{i=1}^{\infty} [\lambda/i + \mu/i^2]$ where λ and μ are constants. Since this sum is not finite, the condition of equations (5) is not satisfied. It can be easily shown that when $f(i) = 1/i^2$, equation (5) is satisfied. It is also possible to specify other forms of $f(t-i)$ consistent with the conditions of equation (5) and any of them can be imposed on the coefficients of the scheme to retain fluctuations finite.

III. *Correlogram of the Simple Model*

Since it can be seen from the solution of the simple scheme of equation (2) given in the previous section that $X(t)$ for different values of time, are elements of a Hilbert space, the expectation of any two of them can be had by taking their inner product. For further work, let the random disturbances, ε's, have a zero mean and variance σ^2. These disturbances being random independent variables, which otherwise form an orthonormal system, can be defined over $T = (a, b)$ belonging to L_2 space $(a \to -\infty, b \to \infty)$ so that $X(t)$'s are as described above.

Then

$$E[X^2(t)] = \text{Var. } X(t)$$

$$= (X(t), X(t)) \text{ is the definition (of the inner product).}$$

$$= \left[\sum_{r=1}^{\infty} \{ \prod_{i=1}^{r} a(t-i) \} \varepsilon(t-r), \sum_{r=1}^{\infty} \{ \prod_{i=1}^{r} a(t-i) \} \varepsilon(t-r) \right]$$

$$= \sigma^2 \{ \sum_{r=1}^{\infty} \prod_{i=1}^{r} a^2(t-i) \} \qquad \ldots \quad (6)$$

Similarly,

$$E[X(t)\,.\,X(t+m)] = (X(t),\ X(t+m))$$

where

$$X(t+m) = \sum_{r=1}^{\infty} \Big[\prod_{i=1}^{r} a(t-i) \Big] \varepsilon(t+m-r)$$

for any positive integer m,

so that

$$(X(t), X(t+m)) = \Big(\sum_{r=1}^{\infty}\Big[\prod_{i=1}^{r} a(t-i)\Big]\varepsilon(t-r), \sum_{r=1}^{\infty}\Big[\prod_{i=1}^{r} a(t-i)\Big]\varepsilon(t+m-r)\Big)$$

$$= \Big(\sum_{s=1}^{\infty} \Big[\prod_{i=1}^{s} a(t-i) \Big] \varepsilon(t-s),$$

$$\sum_{r=1}^{m+s-1} \Big\{ \prod_{i=1}^{r} a(t-i) \Big\} \varepsilon(t+m-r)$$

$$+ \sum_{r=m+s}^{\infty} \Big[\prod_{i=1}^{r} a(t-i) \Big] \varepsilon(t+m-r)$$

$$= \sigma^2 \Big\{ \sum_{r=1}^{\infty} \Big[\prod_{i=1}^{r} a(t-i) \prod_{i=1}^{m+r} a(t-i) \Big] \Big\} \qquad .. \quad (7)$$

From equations (6) and (7), the correlation coefficient for lag m, $\varrho(m)$ can be written as,

$$\varrho_x(m) = \frac{E[X(t)\ X(t+m))]}{E[X^2(t)]} = \frac{\sum_{r=1}^{\infty} \prod_{i=1}^{m+r} a(t-i) \prod_{i=1}^{r} a(t-i)}{\sum_{r=1}^{\infty} \prod_{i=1}^{r} a^2(t-i)}$$

$$= 1/\lambda_x, \text{ where} \qquad .. \quad (8)$$

$$\lambda_x = \frac{\sum_{r=1}^{\infty} \prod_{i=1}^{r} a^2(t-i)}{\sum_{r=1}^{\infty} \prod_{i=1}^{m+r} a(t-i) \prod_{i=1}^{r} a(t-i)} \geqslant \left\{ \frac{\sum_{r=1}^{\infty} \prod_{i=1}^{r} a^2(t-i)}{\sum_{r=1}^{\infty} \prod_{i=1}^{m+r} a^2(t-i)} \right\}^{\frac{1}{2}} \qquad .. \quad (9)$$

by Schwarz inequality.

Since the denominator of equation (9) tends to zero and the numerator to a finite limit as $m \to \infty$, and from (4), and so λ_x tends to infinity. Hence $\varrho_x(m)$ tends to zero slowly with increasing m. Thus the nature of the correlogram tending to zero is retained here

also as for the correlogram of the linear autoregressive scheme of first order with constant coefficients, but the limiting process is slow for this model, which is clearly seen from the inequality of (9).

IV. *Limit of the Variates* $S_n(t)$

In order to study further the properties of the model given in equation (2), the variates constituting the partial sums

$$S_n(t) = \sum_{r=1}^{n} X(t-r) \qquad .. \quad (10)$$

for different positive integer values of n, with suitable conditions on the coefficients of the scheme that satisfy equation (4), are taken for consideration.

Theorem: The variates $S_n(t)$ tend to normality in standard measure as $n \to \infty$.

Proof:

$$\text{Now} \quad S_n(t) = \sum_{r=1}^{n} \sum_{s=1}^{\infty} \left[\prod_{i=1}^{s} a(t-i) \right] \varepsilon(t-s-r)$$

from the equation (3)

$$= \sum_{s=1}^{\infty} \left[\prod_{i-1}^{s} a(t-i) \right] \sum_{r=1}^{n} \varepsilon(t-s-r)$$

$$= \sum_{s=1}^{\infty} \left[\prod_{i=1}^{s} a(t-i) \right] \eta(\overline{t-r}-s) \qquad .. \quad (11)$$

where

$$\eta(\overline{t-r}-s) = \sum_{r=1}^{n} \varepsilon(t-s-r)$$

So that

$$|| \eta(t-r-s) || = || \sum_{r=1}^{n} \varepsilon(t-s-r) ||, \text{ where } || \eta || \text{ is norm } \eta$$

$$= \sqrt{n} \cdot \sigma. \qquad .. \quad (12)$$

Again $(\eta(t-s-n), \eta(t-s-m))$

$$= \left(\sum_{r=1}^{n} \varepsilon(t-r), \sum_{p=1}^{m} \varepsilon(t-p) \right)$$

for any positive integers m and n

$$= m\sigma^2 \text{ if } m < n \qquad .. \quad (13)$$

The η's can also be easily seen as elements of Hilbert space which unfolds with increasing n; and $S_n(t)$'s are also elements of a H-space spanned by η's.

Taking $V_n(t) = E[S_n^2(t)] = (S_n(t), S_n(t))$, by definition, which can be written as

$$= \Big(\sum_{s=1}^{\infty} \prod_{i=1}^{s} a(t-i)\,\eta(t-s-n),$$

$$\sum_{s=1}^{\infty} \prod_{i=1}^{s} a(t-i)\,\eta(t-s-n)\Big)$$

$$= \sum_{s=1}^{\infty} \prod_{i-1}^{s} a^2(t-i)\ (\eta(t-s-n), \eta(t-s-n))$$

$$+ \sum_{r=1}^{\infty} \sum_{s=1}^{\infty} \prod_{i=1}^{r} a(t-i) \prod_{j=1}^{s} a(t-j)\,(\eta(t-s-n),$$

$$\eta(t-s-m)).$$

Since $(f+g, f+g) = (f, f) + (g, g) + (f, g) + (g, f)$ from the definition of scalar product for elements f and g of a H-space, this can be further simplified using the results of equations (11) and (12) and reduced to the form

$$V_n(t) = n\sigma^2 \sum_{s=1}^{\infty} \prod_{i=1}^{s} a^2(t-i) +$$

$$m\sigma^2 \sum_{r=1}^{\infty} \sum_{s=1}^{\infty} \prod_{i=1}^{r} a(t-i) \prod_{j=1}^{s} a(t-j)$$

$$\text{for } m < n \text{ and } r \neq s. \qquad \ldots (14)$$

Hence

$$\frac{V_n(t)}{n} = \sigma^2\Big[\sum_{s=1}^{\infty} \prod_{i=0}^{s} a^2(t-i) +$$

$$(m/n) \sum_{r=1}^{\infty} \sum_{s=1}^{\infty} \prod_{i=1}^{s} \prod_{j-1}^{r} a(t-i)\,a(t-j)\Big] \qquad \ldots (15)$$

Since the first part of the sums on the right hand side of the above equation is finite from the condition given in equation (4) and the second part

$$\sum_{r=1}^{\infty}\sum_{s=1}^{\infty}\prod_{i=1}^{r}\prod_{j=1}^{s} a(t-i)\,a(t-j) \text{ is}$$

$$\leqslant \{[\sum_{r=1}^{\infty}\prod_{i=1}^{r} a^2(t-i)]\,[\sum_{s=1}^{\infty}\prod_{j=1}^{s} a^2(t-j)]\}^{\frac{1}{2}}$$

by Schwarz's inequality,

which is $< (k\,.\,k')^{\frac{1}{2}}$ where k and k' are constants again from the condition of equation (4) so that for large n, $V_n(t)/n$ tends to a finite limit (say V)

Hence

$$\frac{V_n(t)}{n} \sim V < \infty$$

as $n \to \infty$ .. (16)

Thus the variance $S_n(t)$ is a function of n and increases to a finite limit as n increases when divided by n.

Consider next

$$\begin{aligned} E(|\,S_n(t)\,|^3) &= ||\,|\,S_n(t)\,|\,||^3 \\ &= (|\,S_n(t)\,|,\,|\,S_n(t)\,|^2) \\ &\leqslant ||\,|\,S_n(t)\,|\,||\,.\,||\,|\,S_n^2(t)\,|\,||. \\ \text{since } (f, g) &\leqslant ||\,f\,||\,.\,||\,g\,||\,. \\ &= \{||\,|\,S_n(t)\,|\,||^2\,.\,||\,|\,S_n(t)\,|^2\,||^2\}^{\frac{1}{2}} \quad .. \quad (17) \end{aligned}$$

To complete the proof of the theorem it is necessary to show that this third absolute moment of $S_n(t)$ is bounded so that $S_n(t)$ satisfies Liapounoff's conditions from which central limit law can be deduced (see Cramér (1937)).

From equation (3), the sum

$$S_n(t) = \sum_{s=1}^{\infty}\Big(\prod_{i=1}^{s} a(t-i)\Big)\sum_{r=1}^{n}\varepsilon(t-r-s)$$

can be written as

$$\begin{aligned} S_n(t) = a(t)\,.\,\varepsilon(t-2) &+ [\sum_{s=1}^{2}\prod_{i=1}^{s} a(t-i)]\,\varepsilon(t-3) + \ldots . \\ \ldots . &+ [\sum_{s=1}^{n-1}\prod_{i=1}^{s} a(t-i)]\,\varepsilon(t-n) \\ &+ \sum_{s=1}^{\infty}[\sum_{j=0}^{n-1}\prod_{i=1}^{s+j} a(t-i)]\,\varepsilon(t-s-n). \end{aligned}$$

By expanding the right hand side and summing by diagonals taking $|\varepsilon(-t)| = |\varepsilon(t)|$; we have

$$|S_n(t)| \leqslant |a(t)|\varepsilon(t-2) + \Big(\sum_{s=1}^{2} \Big|\prod_{i=1}^{s} a(t-i)\Big|\Big)\varepsilon(t-3) + \ldots$$

$$\ldots + \Big(\sum_{s=1}^{n-1} \Big|\prod_{i=1}^{s} a(t-i)\Big|\Big)\varepsilon(t-n)$$

$$+ \Big|\sum_{s=1}^{\infty} \Big(\sum_{j=0}^{n-1} \prod_{i=1}^{s+j} a(t-i)\Big)\varepsilon(t-s-n)\Big|. \qquad .. \quad (18)$$

The sum

$$\Big|\sum_{s=1}^{\infty}\Big[\sum_{j=0}^{n-1}\prod_{i=1}^{s+j} a(t-i)\Big]\varepsilon(t-s-n)\Big| = \Big|\{a(t) + \prod_{i=1}^{2} a(t-i) + \ldots \prod_{i=1}^{n} a(t-i)\}\varepsilon(t-n-1)$$

$$+\{\prod_{i=1}^{2} a(t-i) + \ldots + \prod_{i=1}^{n+1} a(t-i)\}\varepsilon(t-n-2) + \ldots$$

$$\{\prod_{i=1}^{n-1} a(t-i) + \ldots \prod_{i=1}^{2n-2} a(t-i)\}\varepsilon(t-2n+1) + \ldots\ldots\ldots\Big|$$

$$\leqslant \Big[|a(t)| + \prod_{i=1}^{2} |a(t-i)| + \ldots + \prod_{i=1}^{n} |a(t-i)|\Big]\varepsilon(t-n-1)$$

$$+ \ldots + \Big[\prod_{i=1}^{n-1} |a(t-i)|$$

$$+ \ldots + \prod_{i=1}^{2n-2} |a(t-i)|\Big]\varepsilon(t-2n+1) + \ldots \qquad .. \quad (19)$$

This can be simplified by using the notation

$$\left.\begin{aligned} &\prod_{i=1}^{s} |a(t-i)| = p_s(t) \\ &\sum_{r=1}^{s} p_r(t) = b_s(t) \\ &\text{and } b_{n+s-1}(t) - b_{s-1}(t) = c_s(t) \end{aligned}\right\} \qquad .. \quad (20)$$

so that

$$c_s(t) = \prod_{i=1}^{s} |a(t-i)| + \ldots + \prod_{i=1}^{s+n-1} |a(t-i)|.$$

and tends to zero as $s \to \infty$.

Also

$$\sum_{s=1}^{\infty} c_s^2(t) = \sum_{s=1}^{\infty} \{ \sum_{i=s}^{s+n-1} p_i^2(t) + \sum_{i,j} p_{s+i}(t) \cdot p_{s+j}(t) \}$$

$$< (k_1+k_2+\ldots k_n) + \{ [\sum_{s} \sum_{i=0}^{n-1} p^2_{s+i}(t)] [\sum_{s} \sum_{j=0}^{n-1} p^2_{s+j}(t)] \}^{\frac{1}{2}}$$

by Schwarz's inequality where k's are constants

$$< (k_1+k_2+\ldots k_n) + (k_1+k_2+\ldots k_n)$$

$< K$. a finite quantity from equation (4).

so that $\sum_{s=1}^{\infty} c_s^2(t) < \infty$ .. (21)

Thus, equation (19) with the help of the notation of equation (20) can be reduced to the form

$$| \sum_{s=1}^{\infty} [\sum_{j=0}^{n-1} \prod_{i=1}^{s+j} a(t-i)] \varepsilon(t-s-n) | \leqslant \sum_{s=1}^{\infty} c_s(t) . \varepsilon(t-s-n).$$

giving, from equation (18),

$$| S_n(t) | \leqslant \sum_{i=1}^{n-1} b_i(t) \varepsilon(t-i-1) + \sum_{s=1}^{\infty} c_s(t) \varepsilon(t-s-n) \quad .. (22)$$

This can be further reduced as

$$| S_n(t) | \leqslant \sum_{r=1}^{\infty} d_r(t) \varepsilon(t-r-1) \quad .. (23)$$

where

$$d_r(t) = b_r(t) \text{ for } r = 1 \text{ to } n-1$$

and

$$d_{n+i-1}(t) = c_i(t) \text{ for } i = 1 \text{ to } \infty$$

so that

$$\sum_{r=1}^{\infty} d_r^2(t) < \infty \text{ from equation (21).} \qquad \ldots \qquad (24)$$

Now

$$|| \, | S_n | \, ||^2 \leqslant || \sum_{r=1}^{\infty} d_r(t)\,\varepsilon(t-r-1) \, ||^2$$

$$\leqslant \Big(\sum_{i=1}^{n-1} b_i^2(t) + \sum_{s=1}^{\infty} c_s^2(t) \Big)\, \sigma^2$$

since ε's form an orthonormal system.

$$< \text{a finite quantity from equation (21)}$$

$$\text{or} \quad < \infty. \qquad \ldots \qquad (25)$$

Again

$$|| \, |S_n| \, ||^4 = \mathbf{E}(|S_n|^4)$$

$$\leqslant [|| \sum_{r=1}^{\infty} d_r(t)\,\varepsilon(t-r-1) \, ||]^4$$

$$\leqslant \mu_4 \sum_{r=1}^{\infty} d_r^4(t) + 4\mathbf{E}\Big[\sum_{r,\,s} d_r^3(t)\, d_s(t)\, \varepsilon^3(t-r)\varepsilon(t-s) \Big]$$

$$+ 6\,\mathbf{E}\Big[\sum d_r^2(t)\, d_s^2(t)\, \varepsilon^2(t-r)\, \varepsilon^2(t-s) \Big]$$

$$+ 6\mathbf{E}\Big[\sum d_r^2(t)\, d_s(t)\, d_u(t)\, \varepsilon^2(t-r)\, \varepsilon(t-s)\, \varepsilon(t-u) \Big]$$

$$\ldots + 4\mathbf{E}[\Sigma\, d_r(t)\, d_s(t)\, d_u(t)\, d_v(t)\, \varepsilon(t-s)\, \varepsilon(t-r)\ \ \varepsilon(t-u)\, \varepsilon(t-v)\,].$$

where μ_4 is the fourth moment of ε's that will be σ^4 and hence is finite. Each term of this summation can be shown as finite by repeated application of Schwarz's inequality.

Thus

$$\mathbf{E}(\Sigma d_r^2(t)\, d_s^2(t)\, \varepsilon(t-r)\, \varepsilon(t-s)) \leqslant \{\mathbf{E}(\Sigma d_r^4(t)\, \varepsilon^4(t-r)) \cdot \mathbf{E}(\Sigma d_s^4(t) \cdot \varepsilon^4(t-s))\}^{\frac{1}{2}}$$

$$< \mu_4 \, \Sigma\, d_r^4(t)$$

$$< \infty \text{ from (25)}$$

Again

$$\begin{aligned} E[\Sigma\, d_r^3(t)\, d_s(t)\, \varepsilon^3(t-r)\, \varepsilon(t-s)] \\ &\leqslant \{E(\Sigma d_r^6(t) \cdot \varepsilon^6(t-r)) . E(\Sigma d_s^2(t) . \varepsilon^2(t-s))\}^{\frac{1}{2}} \\ &< \{\mu_6(\Sigma\, d_r^6(t)) \cdot \sigma^2 \cdot \Sigma\, d_s^2(t).\}^{\frac{1}{2}} \\ &< \{\sigma^8\, \Sigma\, d_r^6(t) .\ \Sigma\ d_s^2(t)\}^{\frac{1}{2}} < \infty \text{ from (24) and (4)} \end{aligned}$$

so that

$$|| \ |S_n(t)| \ ||^4 < \infty \qquad .. \quad (27)$$

using the results of equations (25) and (27) in equation (17) we get $E(|S_n(t)|^3) < \infty$ for every given n. Thus Liapounoff's conditions are satisfied by $S_n(t)$ and hence tends to normality as n tends to infinity, it being expressed in the standard measure.

This result, besides giving an additional property of the schemes, can be used to develop tests to study the independence of two observed series following similar schemes of the same order.[2] In a recent paper Moran (1947) obtained the analogous results for autoregressive schemes with constant coefficients.

If $S_n^*(t) = 1/n\ S_n(t)$, then S_n^* is distributed asymtotically normal and is called an equidistributed variate which is of importance in the theory of estimation.

V. *Correlogram of the sum* $S_n(t)$

For any finite integer values m and n, if $m < n$,

$$(S_n(t), S_m(t)) = (\sum_{s=1}^{\infty} [\prod_{i=1}^{s} a(t-i)]\eta(t-s-n),$$

$$\sum_{s=1}^{\infty} [\prod_{i=1}^{s} a(t-i)\eta(t-s-m))$$

from equation (11)

$$(\sum_{s=1}^{\infty} \prod_{i=1}^{s} a(t-i))^2 (\eta(t-s-n), \eta(t-s-m)$$

$$= [\sum_{s=1}^{\infty} \prod_{i=1}^{s} a^2(t-i) + \sum_{s=1}^{\infty} \sum_{r=1}^{\infty} \prod_{i=1}^{s} a(t-i)$$

$$\prod_{j=1}^{r} a(t-j)]m \cdot \sigma^2 \text{ for } r \neq s.$$

from equation (13)

2. Work is in progress in this direction and the results will be published soon.

If $\varrho_s(k)$ is the correlation coefficient of $S(t)$'s for the time lag $(n-m)$ equal to $k > 0$

$$\varrho_s(k) = \frac{E[S_n(t) \cdot S_m(t)]}{E[S_n^2(t)]}$$

$$= \frac{m\sigma^2\{\sum_{s=1}^{\infty}\prod_{i=1}^{s} a^2(t-i) + \sum_{r=1}^{\infty}\sum_{s=1}^{\infty}\prod_{i=1}^{r}\prod_{j=1}^{s} a(t-i)\,a(t-j)\}}{n\sigma^2\{\sum_{s=1}^{\infty}\prod_{i=1}^{s} a^2(t-i) + m/n \sum_{s=1}^{\infty}\sum_{r=1}^{\infty}\prod_{i=1}^{s}\prod_{j=1}^{r} a(t-i)\,a(t-j)\}}$$

from equation (17).

This can be written as

$$\varrho_s(k) = \frac{p(1+\lambda_s)}{1+p\lambda_s}$$

where $p = m/n$

and

$$\lambda_s = \frac{[\sum_{s=1}^{\infty}\sum_{r=1}^{\infty}\prod_{i=1}^{r} a(t-i)\prod_{j=1}^{s} a(t-j)]}{[\sum_{s=1}^{\infty}\prod_{i=1}^{s} a^2(t-i)]} \qquad \ldots (28)$$

For any finite m as the lag $k \to \infty$, $\varrho_s(k) \to o$. Again as $k \to o$, so that $p \to 1$, $\varrho_s(k) \to 1$. Further, for any infinite k with large n and m, $\varrho_s(k)$ steadily decreases with increasing k. Thus the correlogram of $S_n(t)$ exhibits similar properties of the correlogram of $x(t)$ given in equation (8) with the value falling from 1 to 0 with increasing lag. But the correlogram of $S_n(t)$ tends to zero more rapidly than that of $x(t)$. This can be expected as the variates $S_n(t)$ are partial sums of $x(t)$'s and hence retain greater dependence between variates for any lag than for $x(t)$'s, for the corresponding lag. Hence the rapidity in fall.

Even if the condition of equation (4) is not satisfied by the coefficients $a(t-i)$, since

$$\sum_{s=1}^{\infty}\sum_{r=1}^{\infty}\prod_{i=1}^{s} a(t-i)\prod_{j=1}^{r} a(t-j) \leqslant \sum_{s=1}^{\infty}\prod_{i=1}^{s} a^2(t-i)$$

by Schwarz's inequality,

so that right side tends to infinity more rapidly than the left, still $\lambda_s \to 0$, though slowly, and hence $\varrho_s(k)$ also tends to zero

rather slowly as $k \to \infty$. This result can be also established for $m > n$ by taking $p = n/m$ and $k = (m-n)$.

VI. *Practical Illustration of the Scheme*

For the study of family budget data, let q be the budget alternative consisting of k components represented by $q_i (i = 1 \text{ to } k)$ that are non-negative. Then q can be taken as a point in the k-dimensional space which is called the budget space, denoted by Ω. Following Wold (1952), $f_r(q)$ for different values of q represents the budget alternatives for a specified consumer and for a fixed budget period r. $f_r(q) = c$, where c is a constant, forms a well defined point set in the budget space for all q in Ω. Hence for different periods r, the functions $f_r(q)$ will be random variables of Ω so that the repeated realisation of budget alternatives can be considered as a stochastic process.

The budget components for any period depend to some extent on the corresponding components of previous periods and on the influence of various other factors. In the simple situation, if the components are determined by the corresponding components of the previous period and some random disturbances that represent the influence of all other factors, the relationship can be shown in the form of equation

$$f_n(q) = a_{n-1}(q)\, f_{n-1}(q) + \varepsilon_n(q) \qquad .. \quad (29)$$

where $a_{n-1}(q)$ gives the combined influence of all components at period $(n-1)$ on the components at the period n, and $\varepsilon_n(q)$ is the total of the random disturbances arising in period n influencing all the budget components. Since various budget components differ in the extent of their influence, being related to their values at any given period on the corresponding components of the next period, the coefficient $a_{n-1}(q)$ depends on n and is not fixed for different periods. Thus the scheme of equation (29) can be seen as an extended form of the simple stochastic model with time-trending coefficients given in equation (2). If the random disturbances constituting $\varepsilon_n(q)$ are mutually independent then

$$\varepsilon_n(q) = \prod_{i=1}^{k} \varepsilon_n(q_i). \qquad .. \quad (30)$$

where $\varepsilon_n(q_i)$ is the disturbance on the ith budget component, so that equation (29) becomes

$$f_n(q) = a_{n-1}(q)\, f_{n-1}(q) + \varepsilon_n(q) \qquad .. \quad (31)$$

with the solution

$$f_n(q) = \sum_{s=1}^{\infty} \prod_{i=1}^{s} a_i(q) \,.\, \varepsilon_{n-s}(q). \qquad .. \quad (32)$$

Even if $\varepsilon_n(q_i)$ are only independent and not mutually, k can be expressed with a dyad scale in the form

$$k = l_1 + l_2 \,.\, 2 + l_3 \,.\, 2^2 + \ldots\ldots$$

where

$$l_v = \begin{cases} 1 & \text{if } v = v_1,\ v_2, \ldots . v_r \\ 0 & \text{otherwise,} \end{cases}$$

so that

$$\varepsilon_n(q) = \varepsilon_{v_1}(q) \,.\, \varepsilon_{v_2}(q) \ldots \varepsilon_{v_r}(q)$$

will be a random independent variable and hence $\{\varepsilon_n(q)\}$ becomes an orthonormal sequence.

It can be shown that for the model represented by equation (31) with the random disturbances forming a random independent variable if it is possible to divide the random components into p factors or important groups, then also the distributions of partial sums of $f_n(q)$ for some or all p, tend to normality as $n \to \infty$.

For $\varepsilon_n(q) = \varepsilon_n^{(p)}(q)$, and it is known that $\sum_{s=1}^{\infty} \prod_{i=1}^{s} a_i(q)\, \varepsilon_n^{(p)}(q)$ is almost everywhere convergent for p 1, 2 ... if and only if $\sum_{s=1}^{\infty} \prod_{i=1}^{s} a_i^2(q) < \infty$ so that even if some of the factors are ignored in $\varepsilon_n^{(p)}(q)$ the property of the finiteness of the fluctuations and consequently their representation as elements of H-space is not disturbed. (See Bohman (1949)). Thus $f_n(q)$ belongs to L_2 space for every p and hence for all p the $f_n(q)$ of equation (31) remain almost everywhere convergent so that the distribution of partial sums tends to normality by theorem proved in Section IV.

Thus it is seen that simple stochastic schemes with time-trending coefficients present realistic economic models for the analysis of family budget data. This is only an illustration and it is possible to enlist many practical situations where these models give appropriate representation of observed time-series.

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55. **Radha, K. (Miss) :** *The Enzymic activity of* Macrophomina phaseoli (*Maubl.*) *Ashby.* **Proc. Indian Acad. Sci., B, 38: 231-234, 1953.**

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1. The number of genera of fungi developing from colonised root pieces depends on the concentration of the surface-sterilising agent used and the duration of the treatment given.

2. For the development of the maximum number of genera of fungi, treatments of 2 minutes immersion each in 0·04% para-nitrophenol and 0.1% $HgCl_2$ (Fred and Waksman's formula) and 10 minutes immersion in a 1 in 14 aqueous suspension of $CaOCl_2$ have proved superior to several other chemicals known to be weakly bacteriostatic or bactericidal..

3. *Fusarium* spp. and *Macrophomina phaseoli* (*Rhizoctonia bataticola*) are the primary and dominant colonisers on autoclaved and freshly excised surface-sterilised root pieces buried in Udamalpet soil.

57. **Chinnayya, E. J., & Agnihothrudu, V.:** *Rhizosphere Microflora of Plants Growing in Different Ecological Habitats.* **J. Madras Univ., B, 23: 182-192, 1953.**

1. Results of a quantitative and qualitative study of rhizosphere microflora of plants growing in three different ecological habitats are reported.

2. Fungal, bacterial and actinomycete numbers of mesophytes were higher than those of the aquatic and marshy plants, as determined by dilution plate technique.

3. The occurrence of specific rhizosphere micro-organisms depended on the particular plant genus or species rather than the ecological habitat.

58. **Mathew, K. T.:** *Studies on the Black Rot of Coffee: I. The Disease in South India and Some General Considerations.* **Proc. Indian Acad. Sci., B, 39:** 133-170, 1954.

The occurrence of *Pellicularia koleroga* Cooke which causes the black rot of coffee has been reported from almost all the tropical countries of the world. In South India the disease is severe only in those areas coming under the influence of heavy S.W.M. rains from June to September. Humidity is the most important single factor which determines the presence of the fungus in any area.

The fungus establishes on its hosts in two distinct forms, viz., the sclerotial form which shows penetration and rotting of the tissues and the pellicle stage which bears the basidiospores and where the growth of the fungus is entirely superficial. The pellicle stage is formed only on healthy tissues under conditions of relatively high humidity.

Young shoots, leaves and berries are infected by the fungus.

The fungus enters the leaves through the stomata, is intercellular and involves all tissues. Certain unidentified crystals formed through fungal metabolism are found associated with the rotting leaves and it is believed that the secretion or secretions help the fungus in the penetration of the tissues.

The disease spreads mostly through contact from plant to plant by means of the vegetative mycelium. Under narrowly defined environmental conditions spread of the disease by means of basidiospores takes place.

The spores remain viable for only a short period. The fungus tides over the unfavourable season by means of vegetative mycelium in localised infection foci on branches.

P. koleroga is unspecialised and plurivorous in nature and under favourable environmental conditions, is capable of infecting a large number of plants belonging to different species, genera and families, although a preference for rubiaceous plants is noticed in Mysore.

Pure cultures of the fungus were isolated from leaves of a few plants showing basidiospores. All isolates were found to be physiologically and morphologically alike. They were all slow growing, had more or less the same rate of growth and produced a brown discolouration on media containing tannic acid. None of the isolates grew on synthetic media unless certain growth substances were supplied and all of them had the same cardinal temperatures for growth.

All the isolates were found to be pathogenic on species of *Coffea* and other plants inoculated.

A closely allied fungus *P. filamentosa* was even more unspecialised in the matter of host selection and was observed on a number of plants. In

culture the fungus made 3 to 5 times faster growth than *P. koleroga*, grew well at comparatively high temperatures and exhibited no growth substance deficiencies. The fungus readily and rapidly infected many plants inoculated, including *Coffea* spp. However, the fungus is not generally observed causing disease on coffee in nature.

The classification of the genus *Pellicularia* proposed by Rogers (1943) is adopted.

59. **Mathew, K. T.:** *Studies on the Black Rot of Coffee: II. Nutritional Requirements of* Pellicularia koleroga *Cooke with special reference to Growth Substances.* **Proc. Indian Acad. Sci., B, 39: 179-211, 1954.**

Pellicularia koleroga Cooke grew best at temperatures varying from 21 to 23°C. and made some growth at 7 to 8°C., but did not grow above 31 to 32°C.

Good growth of the fungus was obtained over a wide range of pH varying from 3.8 to 7.3.

The fungus readily assimilated and grew well on sources of carbon like glucose, mannose, galactose, fructose, maltose, sucrose and starch, fairly well on glycerol and mannitol, poorly on xylose and lactose and made no growth on dulcitol.

Nitrate, ammonium and organic nitrogen were used by the fungus but no growth was possible with nitrite nitrogen.

The fungus did not grow on strictly synthetic media, but grew well on addition of extracts of natural products and fungal mats, staled fungal medium and pure growth substances to the media.

All isolates tried responded to thiamine and its two intermediates namely thiazole and pyrimidine in combination. But, the same isolate on different media and different isolates on the same medium responded differently to thiazole and pyrimidine used separately.

Similarly, different isolates had varying capacities to grow with the addition of riboflavine, biotin and pantothenic acid to the medium. For the same isolate these abilities varied with the composition of the medium. It is believed that in the presence of the above growth substances the fungus is able to slowly synthesise thiamine.

On repeated sub-culturing in artificial media all isolates became more and more dependant on thiamine, while response to the other growth substances was reduced. However, a progressive reduction in the rate and amount of growth was noticed even in the presence of thiamine.

The optimum amount of thiamine for the growth of the fungus determined at the period when the fungus reaches maximum growth, was found

to be near 1·0μg. per 20 ml. of medium. Comparatively large amounts of biotin and riboflavine were found necessary to promote some growth of the fungus, especially after long maintenance in artificial media.

Additions of other growth substances to medium containing optimum amount of thiamine had no effect, but casein hydrolysate increased growth considerably.

The growth of the fungus was not inhibited by excessive doses of thiamine and biotin, while riboflavine in similar doses depressed growth.

The occurrence of different isolates having different capacities for synthesis and also the loss of some of the original capacities for synthesis exhibited by some isolates in culture are very likely due to mutations.

60. **Lakshminarayanan, K.:** *A Simple Technique in Paper Disk Chromatography.* **Archiv. Biochem. & Biophysics, 49: 396-399, 1954.**

A simple technique of chromatographic separation of amino acids on filter-paper disks of 7.5 cm. diam. by horizontal migration is described. By the use of fine capillary tube for irrigation it has been possible to control the rate of irrigation and obtain sharp demarcations of the amino acid bands. The method is particularly useful in biological studies where complex mixtures occur.

61. **Prasanna Varma, R.:** *Soil Conditions and Root Diseases: X. The Tomato Wilt Fusaria.* **J. Indian bot. Soc., 33: 43-72, 1954.**

Thirty-seven isolates of Fusaria were obtained from wilted tomato plants collected from various localities in South India. Cultural characters of all the isolates were studied and compared with those of *Fusarium bulbigenum* Cke. *et* Mass. v. *lycopersici* (Brushi) Wr.. *et* Rg., got from Baarn. The isolates were identified according to Wollenweber and Reinking's classification. *Fusarium bulbigenum* Cke., *et* Mass v. *lycopersici* (Brushi) Wr. *et* Rg., was not found to occur in the localities studied in South India. Comparative pathogenicity of the 38 isolates on Bonny Best variety of tomato indicated that isolate 37 (*Fusarium lateritium* Nees v. *uncinatum* Wr.) was the most virulent and isolate 34 (*Fusarium solani* (Mart.) App. *et* Wr. v. *Martii* (App. *et* Wr.) Wr. the least virulent. Pathogenicity varied with the planting of the seeds i.e., the incubation the fungus had in the soil prior to planting the seeds. 21 and 28 days' incubation appeared to reduce the wilt percentage in green-house experiments, while, when the seeds are planted the same day as the inoculum is lowered, the wilt percentage appeared higher. Mixed inoculation of the most virulent pathogen with the other isolates of Fusaria indicated that in each case, the wilt percentage varied, but no prediction of the virulence of the mixed inoculum could be made on the basis of virulence of the individual isolates. None of the varieties of tomatoes showed any marked resistance to the most virulent pathogen; infection being usually through the places of emergence of rootlets. The pathogen is not seed-borne.

62. **Subramanian, C. V.:** *Three New Hyphomycetes.* **J. Indian bot. Soc., 33:** 28-35, 1954.

This paper deals with three new hyphomycetes recently collected from Southern India: *Lacellinopsis levispora* sp. nov. on dead leaves (of? Lauraceae) from Mercara, Coorg State; *Lomaantha pooga* gen. et. sp. nov. on dead stem of *Areca catechu* L. from Ernakulam, Travancore-Cochin State; and *Polydesmus indicus* sp. nov. on dead spathe of *Cocos nucifera* L., also from Ernakulam.

63. **Subramanian, C. V.:** *Studies on South Indian Fusaria: III. Fusaria Isolated from Some Crop Plants.* **J. Madras Univ., B, 24:** 21-46, 1954.

A systematic account is given of the Fusaria isolated from some crop plants from South India. The host plants and various Fusaria which were isolated from them are listed below.

Amaranthus sp.

*Fusarium semitectum Berk. & Rav.

Ananas sativus Schult.

*Fusarium coeruleum (Lib.) Sacc.
*F. javanicum Koorders
*F. solani (Mart.) App. et Wr. v. striatum (Sherb.) Wr.

Cajanus cajan (Linn.) Millsp.

*Fusarium udum Butler.

Cicer arietinum Linn.

*Fusarium orthoceras App. et Wr.
Fusarium solani (Mart.) App. et Wr. v. martii (App. et Wr.) Wr.
*F. solani (Mart.) App. et Wr. v. minus Wr.

Coriandrum sativum Linn.

*Fusarium chlamydosporum Wr.. et Rg.
*F. avenaceum (Fr.) Sacc.
*F. equiseti (Corda) Sacc.
*F. solani (Mart.) App. et Wr. v. minus Wr.

Cyamopsis teragonoloba Taub.

*Fusarium semitectum Berk. & Rav. v. majus Wr.
*F. scirpi Lamb. et Fautr.
*F. oxysporum Schlecht.
* F. conglutinans Wr. v. citrinum Wr.

Dolichos biflorus Linn.

*Fusarium solani (Mart.) App. et Wr. v. minus Wr.

Gossypium arboreum Linn.

Fusarium vasinfectum Atk.

Lycopersicon esculentum Mill.

Fusarium semitectum Berk. & Rav.
F. equiseti (Corda) Sacc. v. bullatum (Sherb.) Wr.
F. scirpi Lamb. et Fautr.
*F. solani (Mart.) App. et Wr. v. minus Wr.
*F. solani (Mart.) App. et Wr. v. striatum (Sherb.) Wr.

Musa sapientum Linn.

Fusarium semitectum Berk & Rav.

Oryza sativa Linn.

*Fusarium scirpi Lamb. et Fautr.
*F. scirpi Lamb. et Fautr. v. longipes (Wr. et Rg.) Wr.
F. culmorum (W. G. Sm.) Sacc.

Phaseolus radiatus Linn.

*Fusarium solani (Mart.) App. et Wr. v. minus Wr.

Solanum melongena Linn.

*Fusarium equiseti (Corda) Sacc. v. bullatum (Sherb) Wr.
*F. oxysporum Schlecht.
*F. coeruleum (Lib.) Sacc.
*F. solani (Mart.) App. et Wr. v. martii (App. et Wr.) Wr.
*F. solani (Mart.) App. et Wr. v. minus Wr.
*F. solani (Mart.) App. et Wr. v. striatum (Sherb.) Wr.

Asterisks indicate fungi for which the hosts mentioned are new.

Fusarium equiseti. v. *bullatum*, *F. scirpi* v. *longipes* and *F. conglutinans* v. *citrinum* are new records for India.

64. **Kovoor, A. T. A.:** *Some Factors Affecting the Growth of* Rhizoctonia bataticola *in the Soil.* **J. Madras Univ., B, 24: 47-52, 1954.**

Rhizoctonia bataticola is capable of growing in unsterilised soil. An increase of soil moisture increased the activity of bacteria that attack the hyphae in the soil.

The addition of sodium nitrate to the soil inhibits the growth of *R. bataticola*, presumably by stimulating antagonistic soil microflora, especially *Actonomyces* sp.

When calcium superphosphate is added growth is comparatively profuse.

65. **Saraswathi-Devi, L. (Miss):** *Bio-assay of Heavy metals by* Aspergillus niger*—Sensitivity of a new strain:* **Proc. Indian Acad. Sci., B, 40:** 1-7, 1954.

The standard 'M' strain of *Aspergillus niger* van Tiegh. which is being used in many laboratories as a biological test organism to detect the presence of some heavy metals in minute traces has been compared with a new strain of the same fungus, isolated in this laboratory, from the rhizosphere of *Cajanus cajan,* and designated as M.U.B.L.1.

The new strain appeared to be less sensitive to traces of manganese, and more sensitive to copper, and perhaps molybdenum also, than the 'M' strain. Further studies regarding the stability of the new strain and also attempts to secure a greater degree of purity of media are being conducted.

66. **Subramanian, C. V.:** *Fungi Imperfecti from Madras-VI:* **J. Indian bot. Soc., 33:** 36-42, 1954.

In this paper three new species of Fungi Imperfecti are described: *Actiniceps cocos* on *Cocos nucifera, Blodgettia indica* on dead stubble, and *Memnoniella levispora* on dead stems. Three other fungi, viz., *Antromycopsis broussonetiae* Pat. & Trab. v. *minor* Penz. & Sacc., *Chloridium schulzerii* Link., and *Volutina concentrica* Penz. & Sacc., are recorded for the first time from India.

67. **Iyengar, M.O.P.:** *On the Asexual and Sexual Reproduction of* Characiosiphon rivularis *Iyengar.* **J. Indian bot. Soc., 33: 148-151, 1954.**

This paper deals with the asexual and sexual reproduction in *Characiosiphon rivularis* Iyengar, a fresh water alga. A sexual reproduction is by biflagelate zoospores. Sexual reproduction is by planogamy (isogamous or anisogamous).

68. **Sarojini, T.S. (Mrs.):** *Soil Conditions and Root Diseases XI.* Neocosmospora vasinfecta *Smith Disease of* Cajanus cajan. **J. Madras Univ. B, 24:** 137-142, 1954.

An ascogenous fungus identified as *Neocosmospora vasinfecta* Smith, was isolated from roots of wilted *Cajanus* plants in the laboratory experimental plot. The strains evolved from the asexual spore forms of the ascogenous fungus were more pathogenic than the parent strain and *F. udum,* the established wilt pathogen of *Cajanus.* It is suggested that *N. vasinfecta* Smith be classed with the 'soil inhabitant' class of facultative saprophytes like many *Fusarium* spp., since it has been found to occur in many arable and scrub jungle soils examined in this laboratory over many years.

69. **Sundaralingam, V.S.:** *The Developmental Morphology of* Chara zeylanica *Willd.* **J. Indian bot. Soc., 33:** 272-297, 1954.

The structure and development of the stem, the branchlets, the branch, cortex and stipulodes were followed in detail.

The development of the antheridium and of the oogonium was followed in full detail.

Oospores were germinated in the laboratory and all the stages of germination recorded. The details of germination observed were very similar to those recorded by De Bary in other species of *Chara*.

70. **Sadasivan, T.S., & Subramanian, C.V.:** *Recent Advances in the Study of Soil-borne Fusaria.* **J. Indian bot. Soc., 33:** 162-176, 1954.

This paper critically reviews recent work on various aspects of soil-borne diseases of plants caused by Fusaria under the following headings: Status of Fusaria in Southern Indian soils; Fusaria as soil-borne pathogens; soil conditions and the occurrence of wilt and host physiology in relation to Fusarium wilts.

71. **Subramanian, C. V. & Ramakrishnan, K.:** Alpakesa, *A New Genus of the Sphaeropsidales.* **J. Indian bot. Soc., 33:** 203-205, 1954.

In this paper the results of a study of the type specimen of *Neottiospora yuccaefolia* J. G. Hall are presented. It is considered to be distinct from the type species of the genus *Neottiospora* and from any other known genus of the Sphaerosidales, and as such is transferred to a new genus *Alpakesa* as *Alpakesa yuccaefolia* (Hall) Subram. & Ramakr.

72. **Agnihothrudu, V.:** *Some Slime-Moulds from Southern India-I.* **J. Indian bot. Soc., 33:** 177-181, 1954.

In this paper is presented an account of some myxomycetes collected from Madras during the rainy months (September-December, 1953). *Physarum nutans* Persoon and *P. crateriforme* Petch are reported for the first time from India and *P. vernum* Somm. for the first time from Madras State.

73. **Agnihothrudu, V.:** *Some Slime-Moulds from Southern India-II.* **J. Indian bot. Soc., 33:** 182-188, 1954.

Four myxomycetes, namely, *Fuligo septica* Gmelin, *Physarum nicaraguense* Macbride, *Diderma hemisphericum* (Bull.) Hornem., *Arcyria cinerea* (Bull.) Pers., collected from Madras are described in this paper.

74. **Kalyanasundaram, R.:** *Soil Conditions and Root Diseases.* **XII.** *The Role of Zinc and Manganese in Altering Host Metabolism.* **J. Indian bot. Soc., 33:** 197-202, 1954.

1. The wilt susceptible variety of cotton plants (*Gossypium arboreum*) has a higher reserve of ascorbic acid, carbohydrate and reducing sugars when grown in soil amended with zinc.

2. The cotton plants grown in zinc treated soil, have their ascorbic acid and carbohydrate metabolism similar to that of the wilt resistant strain of cotton (*Gossypium hirsutum*) reported elsewhere, and this may be responsible for the resistance acquired by zinc treated plants reported earlier by Sulochana.

3. Since zinc is known to be responsible for the production of growth producing auxin and also very essential for the growth of Asiatic cotton (*G. arboreum*) than American cotton (*G. hirsutum*), the higher reserve of Vitamin C and carbohydrate in zinc treated Asiatic cotton (*G. arboreum*) may be due to good plant growth in the presence of auxin(s) induced by the zinc amendment.

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39. **Gnanamuthu, C. P.** *Two new sand-dwelling Isopods from the Madras sea-shore.* **Ann. Mag. nat. Hist. Ser. 12, 7: 257-273.**

The external morphology with brief notes on internal anatomy and bionomics of our marine isopods, *Brivipleonida gracilis* gen. et. sp. nov. and *Robustura predatories* gen. et. sp. nov. are given.

40. **Krishnan, G.:** *Tyrosinase activity in relation to phenolic tanning.* **Proc. nat. Inst. Sci. India. 20: 157-167.**

Tyrosine and tyrosinase which occur in the blood, its relation to the phenolic tanning of the cuticle in *Carcinus maenas* are studied.

41. **Krishnaswamy S.** *Pelagic copepoda of the Madras coast.* **J. zool. Soc. India. 5: 64-75 (1953).**

An account of 21 species of Harpacticoids collected from the plankton is given.

42. **Krishnaswamy, S.** *A new species of Harpacticoid copepod from Madras.* **Zool. Anz.** Leipzig. **152.:** 88-92.

Full description of *Zausodes,* a new species is given.

43. **Sebastian V. O.** *On* Polyclinum indicum *a new ascidian from the Madras coast.* **J. Washington Acad. Sci. 44: 18-23.**

Full description of this new species and its larval organisation is given.

44. **Pampapathi Rao, K.:** *Bionomics of* Ptychodera flava. **J. Madras Univ. B. 24: 1-5.**

Observations on the burrowing, feeding and spawning of *Ptychodera flava* occurring in Krusadai Islands are given. They occur in coral sand, rough coral detritus exposed to strong surf and in the crevices of dead corals without sand. From the occurrence of Tornaria during different seasons of the year more than one breeding period annually is suggested.

45. **Daniel, A.:** *Some new cirripedes from the Madras coast.* **J. Madras Univ. B. 23 : 219-226. (1953).**

Four new cirripedes from the Madras coast, three belonging to the genus *Lepas* and one to the genus *Octolasmis* are described in detail. Of these, the *Lepas* Spp. are new geographical sub-species while *Octolasmis clubii* is a new species.

46. **Daniel, A.:** *The attachment of Barnacle cyprids to different types of South Indian Timber.* **Ibid. 23.** 226-231. (1953).

The result of a series of experiments conducted in the Madras harbour on the rate of attachment of barnacle cyprids to different S. Indian timbers like Teak (*Tectona grandis*) venteak (*Gmelina arborea*) Dealwood (*Myristica fragrans*) Margosa (Neem) (*Azadirachta indica*), Portia wood (*Thespesia populnea*) Marudu (*Terminalia arjuna*) and Mango (*Mangifera indica*) are described. It was found that the number of barnacle cyprids that had settled on Margosa (*Azadirachta indica*) was lower than the number settling on teak. The probable reasons for different rate of attachment are discussed.

47. **Daniel, A.:** Conchoderma indicum. *n. sp. A pedunculate cirripede from Krusadai Ils.* **J. zool. Soc. India. 5:** 235-238.

Full description of this new species with a key for the identification of the other known species of this genus is given.

48. **Daniel, A.:** *Seasonal variations and the succession of the fouling communities in the Madras Harbour water.* **J. Madras Univ. B. 24:** 189-212.

The animal community which settle and foul the timber are studied. The number of different species of barnacles — the most important of the animal community — and other animals which settle on wooden test panels is recorded during the several months, and seasonal and monthly variations noted. The importance of primary film and the settling of sedentary organism is given with results of seasonal succession of animal communities.

49. **Mahadevan, S.:** *The digestive system of* Mugil crenilabis—*a plankton feeder.* **J. Madras Univ. B. 24:** 143-160.

The gross anatomy and histology of the digestive tract of *Mugil crenilabis* (Forsk), a plankton feeder is fully described.

50. **Ramalingam, K.:** *A new genus of trematode* (Chauhaunea) *from the gills of* Sphyraena acutipinnis *Day.* **J. zool. Soc. India. 5:** 59-63, 1953.

A complete description of this new genus is given with a comparison with the allied genera.

51. **Ramaswamy, T. S.:** *Carbohydrate and fat contents of fishes.* **J. Madras Univ. B. 23:** 232-238.

Only a trace of carbohydrate was found in *Saurida tumbil* and *Octolithus ruber*. The absence of large reserves of carbohydrates may be due to the fact that the copepods and other invertebrates on which the fishes feed do not have appreciable amounts of carbohydrates. This again is obviously because the diatoms on which these invertebrates feed never have a storage of starch. The small quantities of glycogen detectable in copepods and other invertebrates are sufficient for their tissue metabolism and so there are no large reserves to be passed on to the fish. Consequent on the absence of carbohydrate reserve all the fat the fish contains must be derived from the food as fat.

52. **Vijayaraghavan, P.:** *Food of the Indian Herrings.* **J. Madras Univ. B. 23:** 239-247 (1953).

From the analyses of the stomach contents of *Pellona elongata* (*Benn*), *P. indica* (Swains), *P. hovenii* (Blkr), and *P. brachysoma* (Blkr) it was found that teleosteans and crustaceans form two major food items, and when more crustaceans were consumed only a small volume of teleosteans formed the food and *vice versa*. Some notes on the migration of these are also added.

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43. **Shanmugasundaram, E. R. B.** and **Sarma, P. S.**: *Role of pyridoxine in tryptophane metabolism studied in rice moth larva (Corcyra cephalonica st.)* **Curr. Sci. 23: 16, 1954.**

Rice moth larva is made pyridoxine deficient by using a purified diet. The pyridoxine deficient and supplemented larva are fed tryptophane or kynurenine or 3-hydroxy anthranilic acid. In the case of pyridoxine deficient larva fed tryptophane and kynurenine, the total nicotinic acid is much less than that contained in pyridoxine fed larva showing that the deficient larva are unable to convert appreciable amount of added tryptophane and kynurenine to nicotinic acid. Further, the deficient larvae excrete yellow coloured feces. However, in the case of pyridoxine deficient and supplemented larvae fed 3-hydroxy anthranilic acid the total nicotinic acid contents are the same and no yellow coloured feces are excreted. The possible site of action of pyridoxine in the conversion of tryptophane to nicotinic acid in rice moth larva is explained.

44. **Ramachandran, L. K.** and **Sarma, P. S.**: *The effect of thiouracil and thyroxine feeding on the catalase level in the liver of the rat.* **J. sci. industr. Res. 13 B: 115, 1954.**

Thiouracil administration elevates liver catalase level in both male and female rats, whereas thyroxine exerts a depressing action. In both cases males respond more markedly than female rats. Normal levels for liver catalase in female rats is lower than that for male rats. The possible factors that may be involved in inducing marked changes during thiouracil thyrotoxicosis and prolonged thyroxine administration to rats of either sex have been discussed.

45. **Tirunarayanan, M. O.** and **Sarma, P. S.**: The relationship *between folic acid and biotin.* **Curr. Sci. 23: 55, 1954.**

The production of amylase and riboflavin are inhibited by γ-hexachlorocyclohexane in *A. oryzae* and biotin is able to overcome the inhibitory effect. In presence of folic acid, γ-hexachlorocyclohexane inhibits the production of amylase and riboflavin by *A. oryzae* to a far greater extent than its absence although folic acid itself does not have any effect in the absence of the insecticide. An instance of antagonism between folic acid and biotin is reported.

46. **Shanmugasundaram E. R. B.** and **Sarma, P. S.:** Role of carbohydrates *on the biosynthesis of nicotinic acid in germinating green gram.* **J. Madras Univ. B, 24:** 13, 1954.

A study on the effect of various carbohydrates like glucose, fructose, mannose, half glucose half fructose mixture on the biosynthesis of nicotinic acid when present in the medium during germination of green gram has been made. The presence of glucose or mannose has no influence on the biosynthesis of nicotinic acid whereas the presence of fructose or sucrose lowers the nicotinic acid synthesis. The adverse effect produced by fructose or sucrose is attributed to the hitherto unknown metabolic role of the carbohydrates in the conversion of tryptophan to nicotinic acid. A modified form of the chemical method of nicotinic acid estimation has been worked out which gives values agreeing very well with that obtained by the microbiological assay.

47. **Tirunarayanan, M. O.** and **Sarma, P. S.:** *Influence of some B vitamins on the conversion of desthiobiotin into biotin by* Neurospora crassa. **J. Madras Univ. B, 24:** 117, 1954.

Experiments indicate that the Ascomycete fungus, *Neurospora crassa*, is able to convert desthiobiotin into biotin using inorganic sulphur. Using antivitamins of folic acid, pyridoxine, pantothenic acid it has been found that none of these three vitamins are involved in the conversion of desthiobiotin into biotin in the mould.

48. **Tirunarayanan, M. O.,** and **Sarma, P. S.:** *Role of biotin in carbohydrate metabolism of* Aspergillus oryzae. **J. Madras Univ. B, 24:** 125, 1954.

Results of experiments carried out with a strain of *A. oryzae* by the technique of inhibition analysis using, γ, 3, 4- (ureylenecyclohexyl) -buttyric acid and biotin sulphone as the antibiotin compounds, indicate that biotin has a pronounced influence on certain enzyme systems in the field of carbohydrate metabolism of the mould. Biotin is able to influence the oxidative dissimilation of pyruvate, succinate, lactate, malate and glucose in this organism. It is suggested that biotin may function in these systems not as a component or a prosthetic group but only by influencing the synthesis of the whole or parts of the enzyme systems that are able to metabolize these compounds.

49. **Sundaram, T. K., Radhakrishnamurty, R.** and **Sarma, P. S.:** *Metabolism of nicotinic acid and nicotinamide in rice moth-larva.* **Curr. Sci. 23:** 92, 1954.

Rice moth larva is fed on a purified diet supplemented separately with nicotinic acid and nicotinamide. The excreta are extracted with water, the extract chromatographed and the excretary product is found to be nicotinic

acid irrespective of whether nicotinic acid or its amide is fed to the larva. N'-methylnicotinamide is completely absent. It is suggested that methylation of nicotinic acid does not take place in the larva and that nicotinamide is deamidated prior to excretion.

50. **Sundararajan, T. A.** and **Sarma, P. S.:** *Preparation of dephosphorized casein by an enzymic method.* **Nature, 173:** 685, 1954.

Casein is dephosphorised enzymatically by a purified preparation of phosphoprotein phosphatase prepared from ox spleen. The dephosphorised casein is a white amorphous powder lighter than casein, relatively insoluble in water and soluble in alkali. Its solubility in dilute acids is greater than that of casein. The dephosphorised casein is precipitated from its alkaline solution by acidifying to pH 6·0 showing a shift in the isoelectric point of casein to the alkaline side during dephosphorylation. The protein has a nitrogen content of 15·7 per cent. and 0·03 per cent. of phosphorous. No drastic changes appear to take place during enzymic dephosphorylation as seen by the estimation of some amino acids. The protein is attacked by preoteolytic enzymes.

51. **Sivaramakrishnan, V. M.,** and **Sarma, P. S.:** *The influence of vitamins on nitrogen metabolism: Part II—The influence of neopyrithiamine, r-3, 4- (ureylenecydohexyl) butyric acid and aminopterin on amino acid changes during germination.* **J. sci. industr. Res. 13 (B):** 413, 1954.

During germination of green gram there is a marked fall in glutamic acid and a considerable rise in aspartic acid. Both neopyrithiamine and γ-3, 4-(ureylenecydohexyl) -butyric acid inhibit these two metabolic changes producing an accumulation of glutamic acid and a fall in the aspartic acid synthesized. Glutamic acid is the major source of aspartic acid formed, though not the sole source. A probable pathway of conversion from glutamine to asparagine through α-keto glutaric acid and succinic acid is proposed and thiamine takes part in the conversion. Aminopterin decreases considerably only the histidine levels.

52. **Sundararajan, T. A.,** and **Sarma, P. S.:** *Phosphoprotein phosphatase from rat spleen.* **Biochem. et Bioph. Acta. 13:** 588, 1954.

A purified preparation of phosphoprotein phosphatase from rat spleen is prepared. The enzyme is completely free from phosphomonoesterase activity and attacks all the three casein fractions employed with equal vigour, the maximum activity being obtained in each case at pH 5·8. From these and similar other studies, it is concluded that phosphoprotein phosphatase is an enzyme quite distinct from phosphomonoesterases.

53. **Tirunarayanan, M. O.,** and **Sarma, P. S.:** *Studies on biotin: Part VI—Influence of biotin on the inositol- r-hexachloro-*

cyclohexane relation in Aspergillus oryzae. **J. sci. industr. Res. 13 (B):** 488, 1954.

Evidence is presented to indicate that the gamma isomer of hexachlorocyclohexane exerts a nonspecific inhibitory action on amylase and riboflavin synthesis in *A. oryzae* and the inhibitoryeffects are not overcome by inositol. Biotin alone is able to overcome the inhibitory effect and other vitamins of the 'B' group do not significantly affect the metabolism of the fungus in presence of the inhibitor. Folic acid augments the toxicity of the insecticide and in presence of folic acid the insecticide inhibits the synthesis of amylase and riboflavin to a greater extent than in its absence. In the presence of folic acid, however, biotin is not able to overcome the inhibitory effect of the insecticide.

54. **Shanmugasundaram, E. R. B.,** and **Sarma, P. S.:***Tryptophane. utilization by* Neurospora crassa *and the influence of the pure acids.* **Curr. Sci. 23:** 224, 1954.

The influence of 21 amino acids added singly to the medium on the utilisation of tryptophane by a nicotinic acid dependent strain of *Neurospora crassa* is studied. L—leucine, DL—isoleucine, L—hydroxy proline, DL—valine, DL—threonine, DL—β—phenylalanine, DL—methionine, L—cysteine, glycine, L-tyrosine, DL—alanine, DL—serine, and β—alanine are found to inhibit the utilisation of tryptophan the inhibition index varying from 4 to 100. L—histidine, L—glutamic acid, L—citrulline, L—lysine and DL—ornithine have no influence. It is suggested that certain amino acids inhibit the various enzyme systems which take part in the conversion of tryptophane to nicotinic acid.

55. **Radhakrishnamurty, R.,** and **Sarma, P. S.:** *Paper chromatography of pteroylglutamic acid.* **Cur. Sci. 23:** 266, 1954.

A rapid easy method with phenol as the solvent has been worked out for the identification of pteroylglutamic acid. The vitamin is oxidised by permanganate to 2-amino-4-hydroxypteridine-6-carboxylic acid prior to spotting, as this compound is found to give an intense fluorescence in ultraviolet light. Minimum amount that can be identified is found to be 0·1 gamma of the vitamin.

56. **Sivaramakrishnan, V. M.,** and **Sarma, P. S.:** *The inhibition of neopyrithiamine of asparagine synthesis from glutamic acid and glucose.* **Biochem et. Biophy. Acta. 14:** 579, 1954.

Direct evidence for the formation of asparagine from glutamic acid and glucose and for the inhibition by neopyrithiamine of these conversions have been obtained with the use of uniformly ^{14}C-labelled glutamic acid and

glucose. It is concluded that glucose constitutes the other important source for asparagine biosynthesis in addition to glutamic acid.

57. **Tirunarayanan, M. O., Radhakrishnamurty, R.,** and **Sarma, P. S.:** *Role of biotin in the biosynthesis of riboflavin in* Aspergillus oryzae. **J. sci. industr. Res. 13(B):** 591, 1954.

Using γ-3, 4-(ureylenecyclohexyl)-butyric acid and biotin sulphone, the two antibiotin compounds, a relation between biotin and riboflavin in *Aspergillus oryzae* has been made by the technique of inhibition analysis. A possible role of biotin towards the metabolism of inositol which is primarily responsible for riboflavin formation is suggested rather than a direct function of biotin in the riboflavin synthesis.

58. **Sarma, P. S.:** *Mechanism of enzyme action.* **Curr. Sci. 23: 284, 1954.**

A critical review of a symposium on mechanism of enzyme action edited by W. D. McElroy and Bently Glass has been given.

59. **Sundaram, T. K.,** and **Sarma, P. S.:** *Excretion of nicotinuric acid as a metabolite of nicotinic acid by rice moth larva* (Corcyra cephalonica st). **Curr. Sci. 23:** 398, 1954.

The excretion of nicotinuric acid, the glycine conjugate of nicotinic acid by the rice moth larva in significant amounts when it is fed either nicotinic acid or nicotinamide has been demonstrated by paper chromatography against an authentic sample of nicotinuric acid. The identity of the metabolite was further established unequivocally by elution from the chromatogram, hydrolysis and identification of nicotinic acid and glycine in the hydrolysate. The metabolism of nicotinic acid in this insect larva as against its metabolism in mammals is briefly discussed.

60. **Shanmugasundaram, E. R. B., Tirunarayanan, M. O.,** and **Sarma, P. S.:** *The relation between biotin and tryptophane metabolism studied in* Neurospora crassa — **Biochem, J. 58, 469, 1954.**

γ, 3, 4-(ureylenecyclohexyl)-butyric acid, an antimetabolite of biotin, inhibits the utilisation of tryptophane by a nicotinic acid requiring mutant of *Neurospora crassa*, and this inhibition is overcome by the addition of biotin. This indicates that biotin is involved in the metabolism of tryptophane. Biotin functions in the tryptophane-formylkynurenine reaction since the utilization of formlykynurenine is not affected. The ureylene compound does not affect the utilization of other intermediates in the conversion of tryptophane to nicotinic acid such as kynurenine, 3-hydroxykynurenine and 3-hydroxy anthranilic acid. The possible site of action of biotin is explained.

Madras University : Department of Physical Chemistry
Abstracts of Papers Published, 1954

1. **Santhappa, M.:** *Ferric Azide Ion-Pair as a Photo Sensitizer in the Polymerization of Vinyl Compounds in Aqueous solution.* **J. Madras Univ. B, 24:** 91, 1954.

A new method of photochemical polymerization of vinyl monomers in aqueous solution using the azide radicals is discussed. Various initiation and terminating mechanisms have been examined. The difference in the reactivity of the azide radical as an initiator of polymerization on the one hand and the hydroxyl or chloride radical on the other has been pointed out.

2. **Santhappa, M.:** *Impurities in certain Photochemical Systems involving Radicals in Aqueous Solution.* **Curr. Sci., 23:** 145, 1954.

A quantitative evidence for the effect of organic impurities in the photochemical systems ion-pair complex Fe^{3+} X^-— vinyl monomer in aqueous solution, where X = OH, Cl, (× etc.) and M = acrylonitrile or methyl methacrylate or methacrylic acid has been adduced. Possible ways of interactions of radicals and ions with the impurity have been discussed on the basis of electron affinities and bond dissociation energies.

3. **Santhappa, M., & Vaidhyanathan, V. S.:** *Chain Transfer Reactions in Addition Polymerization of Styrene,* **Curr. Sci. 23:** 259, 1954.

Transfer reactions in the polymerization of styrene at 60°c in the absence as well as in the presence of the catalyst, benzoyl peroxide, have been studied in acetic acid, propionic acid, isobutyric acid, n-butanol, isobutanol, tertiray butanol, and diethyl ketone. The respective rate transfer coefficients have been evaluated.

4. **Santhappa, M.:** *Kinetics of Reactions between chloride Radicals from Photoexcited ion-pair Fe^{3+} Cl^- and vinyl monomers in aqueous solution,* **J. Mad. Univ., B. 24:** 279, 1954.

Photochemical kinetics of the system Fe^{3+} Cl^-—vinyl monomer in aqueous solution have been followed by a study of the dependence of (a)

light absorption fraction by the ion-pair; (b) light intensity; (c) concentration of the monomer; (d) initially added ferrous ion and; (e) quantum yield with regard to ferrous iron production and monomer disappearance upon; (i) rate of ferrous iron production; (ii) overall rate of polymerization and (iii) chain lengths of the polymers. It has been concluded that chloride radicals initiate polymerization and recombination of the active chain endings terminates polymerization.

5. **Santhappa, M.:** *Polymerization of vinyl monomers in aqueous solution by radicals from photoexcited electron transfer reaction in the ion-pair* Fe^{3+} OH^{-}, **J. sci. industr. Res.** (November 1954).

Studies similar to (4) have been carried out and it is concluded that the initiating and terminating mechanisms are similar to those of chloride or azide initiators.

Madras University : Department of Physics
Abstracts of Papers Published, 1954

CRYSTALLOGRAPHY AND CRYSTAL PHYSICS

3. **Ramachandran, G. N.:** *X-ray Anti-reflections in crystals—Part II. Calculation of the Integrated Reflection and Integrated Anti-reflection for an Internal Reflection*, **Proc. Indian Acad. Sci. A. 39:** 65, 1954.

Making use of the theory developed in Part I, the integrated values of the reflected and the anti-reflected intensity have been obtained analytically for an internal reflection of a perfect crystal. Three special cases are considered, namely a symmetrical reflection, an asymmetrical reflection and also when absorption is very heavy. It is found that when absorption is large, the formula for integrated reflection reduces to that for a mosaic crystal, which may be physically explained by the fact that multiple reflections are not allowed to play a prominent part owing to the beam being quickly attenuated by absorption.

4. **Ramaseshan, S.** and **Ramachandran, G. N.:** *Investigation of the Degree of Perfection of a Crystal by means of polarized X-rays*, **Proc. Indian Acad. Sci. A. 39:** 20, 1954.

The paper describes an investigation of the intensity of Bragg reflection when the incident X-rays are polarized and the azimuth of the electric vector is varied with respect to the plane of reflection. It is observed, using natural and ground (211) faces of $NaNO_3$, that the variation of intensity with azimuth of polarization is different for a mosaic and a perfect crystal. Such a difference is in fact to be expected from theoretical considerations. The actual behaviour of both the ground and the natural faces was found to be intermediate between what is predicted by theory for an ideally perfect and an ideally mosaic crystal. By comparing the observed azimuthal variation of the integrated reflection with the theoretical expectation for the two limiting cases, it is possible to assess the degree of perfection of the crystal.

5. **Kartha, G.:** *Unit cell and space group of Morellin.* **Curr. Sci., 23:** 8, 1954.

6. **Sundara Rao, R. V. G., Padmanabhan, V. M.** and **Kartha, G.:** *Unit Cell and Space Group of Morellin*, **Curr. Sci. 23:** 216, 1954.

The tetragonal crystal has $a = b = 15 \cdot 89 \pm 0 \cdot 04$, $c = 11.60 \pm 0 \cdot 02$ Å, and the space-group is P 4_1.

7. **Kartha, G.** and **Ramachandran, G. N.:** *Applications of the Difference—Patterson Technique in Structure Analysis,* **Acta Crystallographica** (in press).

Since all the atoms, except the replaceable atoms, in a pair of isomorphous crystals are relatively unchanged in position, the Patterson synthesis, using for the coefficients the differences in the intensities of corresponding reflections given by the two crystals, would contain peaks only at positions corresponding to vectors joining replaceable atoms with the various atoms in the structure. This "Difference-Patterson" diagram is much more amenable to interpretation than a simple Patterson diagram particularly if the three dimensional diagram is considered. It is found that, by using Buerger's minimum function method, the crystal structure can be determined from it directly in most cases. All centrosymmetric structures can be solved by this method and among the non-centrosymmetric space-groups, a difficulty arises due to duplication of the structure by an artificial centre of symmetry only in 11 space-groups, if the replaceable atoms are in general positions. Methods are also described whereby the positions of the replaceable atoms (which need not be heavy atoms) can be determined by studying sections of the Difference-Patterson. The method has been applied to the phthalocyanines and to the isomorphous pair barium chlorate and barium bromate, with good success.

8. **Lonappan, M. A.:** *Thermal Expansion of Potassium Chlorate,* **Proc. phys. Soc.** (in press).

The complete thermal expansion tensor has been determined for the monoclinic crystal, $KClO_3$ for three ranges of temperature 30° to 90°, 90° to 150° to 200°C. The measurements indicate that the direction of maximum expansion is normal to the O_3 planes and the expansion in all directions parallel to the O_3 planes is small and nearly constant.

PROTEIN STRUCTURES

1. **Ramachandran, G. N.** and **Kartha, G.:** *Structure of Collagen,* **Nature, 174:** 269, 1954.

A structure has been proposed for collagen which is on the whole in better agreement with the various known properties than those suggested earlier. A hexagonal unit cell with $a = 12\text{-}16$ Å and $c = 9{\cdot}5\text{-}9$ Å is assumed and the structure consists of one cylindrical rod of three interconnected helixes per unit cell. Each individual helix has a 3_1 symmetry and three helixes are also arranged with a 3_1 symmetry. A number of hydrogen bonds are formed stabilising the structure and the infrared absorption is also naturally explained.

2. **Ramachandran, G. N.** and **Ambady, G. K.:** *Elements of the helical structure of Collagen,* **Curr. Sci. 23:** 349, 1954.

The earlier structure requires modification in view of the new experimental data with stretched collagen. A helix with $c = 28{\cdot}6$ Å and having ten residues in three turns best fits the X-ray data. Evidence is also presented for a small helix of radius about 1 Å assumed in the earlier structure, and so only a small change is indicated.

ASTROPHYSICS

9. **Alladi Ramakrishnan.:** *A stochastic model of a fluctuating density field II:* **Astrophysical J. 119:** 682, 1954.

The problem of the fluctuations in brightness of the Milky way is discussed in the light of the new picture of continuous distribution of matter. The results of paper I are extended to the case of finite t where t is the extent of the astrophysical system.

10. **Alladi Ramakrishnan.:** *On stellar statistics:* **Astrophysical J.** (in press).

It deals with fluctuations in stellar intensities assuming that the interstellar matter 1) consists of discrete clouds, 2) continuous matter of fluctuating density.

STATISTICAL MECHANICS

11. **Alladi Ramakrishnan.:** *On the molecular distribution functions of a one dimensional fluid I:* **Phil. Mag. 45:** 401, 1954.

The molecular distribution functions of a one-dimensional fluid are derived using the new method of 'basic functions' formulated by the author.

12. **Alladi Ramakrishnan** and **Mathews, P. M.:** *On the molecular distribution functions of a one-dimensional fluid II.* **Phil. Mag. 45: 1054, 1954.**

The results of paper I are extended to the case of a potential discussed by Sells, Harris and Guth.

CASCADE THEORY

13. **Alladi Ramakrishnan** and **Srinivasan, S. K.:** *Two simple stochastic models of a nucleon cascade:* **Prog. Theo. Phys.** (Japan) **12:** (in press), 1954.

Fluctuations in the number of particles above a specified energy in a nucleon cascade are discussed in the case of two models one with finite total cross-section, one with infinite total cross-section.

14. **Alladi Ramakrishnan** and **Srinivasan, S. K.:** *Fluctuations in the number of photons in an electron-photon cascade:* **Prog. Theo. Phys.** (Japan) **12:** (in press), 1954.

Mean square numbers of photons above various energies in a soft cascade shower are calculated.

GENERAL STOCHASTIC THEORY

15. **Alladi Ramakrishnan.:** *Counters with random dead time:* **Phil. Mag. 45: 1050, 1954.**

A Laplace transform solution of the well-known fluctuation problems of counters with random dead time is derived.

Madras University : Department of Mathematics
Abstracts of Papers Published, 1954

4. **Balachandran, V. K.:** *Characterization of $\Sigma\triangle$-rings of subsets*: **Fundamenta Mathematicae 41**: 38-41, 1954.

A family of subsets closed for arbitrary unions and intersections is called a $\Sigma\triangle$-ring. It is shown that such a ring can be characterized lattice-theoretically as a complete lattice possessing an additive basis of special elements called supercompact elements. As a corollary, is deduced a characterization for the Boolean algebra of all subsets of a set.

5. **Balachandran, V.K.:** *A characterization for complete Boolean algebras*: **J. Madras Univ. B. 24**: 273-278, 1954.

A study is first made of the ideal of elements of a lattice with product-complement zero (or sum-complement one). In terms of the (former) ideal, is next obtained a sufficient condition for a complete, distributive lattice to be closed for sum-complements. Finally the last result is employed to derive a characterization for complete Boolean algebras.

Madras University : Department of Geology and Geophysics

Abstracts of Papers Published, 1954

1. **Naidu, P. R. J.:** *Granites and Granites. Series I.* **Indian min. J., 2, 12-17, 1954.**

This series deals with five chief granite types, collected between Madras and Gulburga in the Hyderabad state. The petrographic and chemical characters of the rocks and the optical characters of the minerals are given. They are compared to Niggli's magma types.

2. **Naidu, P. R. J.:** *Cordierites from the burnt rocks of the Jharia and Raniganj Coal-fields.* **Curr. Sci. 23:** 387-389, 1954.

All the types of twins, simple and complex, occurring in these cordierites are described. The optic axial angles, refractive indices and a partial chemical analysis are given. Schemes of extinction for all the types of twinning are drawn.

3. **Leelananda Rao, N.:** *Twins, parallel growths and extinction angles in orthopyroxenes from charnockites.* **J. Madras Univ., B, 24:** 53-60, 1954.

Parallel growths between clino-and ortho-pyroxenes are described. The so-called herring-bone twins in these pyroxenes are the result of accidental growing together of two individuals. Extinction angles are the angles observed in any orthorhombic crystal on sections inclined to all the three crystallographic axes.

4. **Leelananda Rao, N.:.** *Dyke rocks of Pallavaram.* **J. Madras Univ., B, 24:** 213-223, 1954.

The dolerite dykes of Pallavaram closely resemble the Cuddapah dykes in essential mineralogical and petrological characters. There is no break in the values of 2V from $+32°$ to $+40°$ as suggested by Hess.

5. **Ramanathan, S.:** *Plagioclase felspars from the charnokites of Salem:* **J. Madras Univ. B. 24:** 225-236, 1954.

The twin-laws of the plagioclase felspars from the charnokites of Salem are determined. The abundance of albite and pericline twin-laws and the greater representation of untwinned grains are in favour of assigning a metamorphic character to those charnokites.

6. **Ramanathan, S.:** *Shonkinites from the ultrabasic areas of Salem*: **J. Madras Univ. B. 24:** 315-33, 1954.

Shonkinites, rather rare rock types in the world, are described for the first time from India. Their chemical analyses and optical characters of the minerals are determined.

7. **Babu, S. K.:** *Plagioclase felspars from the granites and gneisses of Mysore:* **Q.J.G.M.M.S.** (In Press).

The twin-laws observed in the plagioclase felspars of granites and gneisses of Mysore are described. Albite-ala law is common in these felspars. Köhler and Tertsch values calculated for the several anothite contents agree with the values observed for the various laws.

8. **Babu, S. K.:** *A calciferous amphibole from a xeonolith in granite:* **J. Madras Univ. B. 24:** 307-14, 1954.

Hornblende from an amphibolite, occurring as xenolith in granite, from Bangalore, has been chemically analysed and its optical characters determined. By referring to Sundius' diagram, the amphihole is found to be composed of the molecules pargasite and Edenite.

9. **Raghavan, V. M.:** *Bluish green hornblende from an amphibolite of Jalarpet*: **J. Madras Univ. B: 24**: 245-249, 1954.

The chemical composition and optical characters of the hornblende are determined. It is compared with Winchell's and Hallimond's study of calciferous amphiholes and is found to correspond to amphiholes occurring in gabbros.

10. **Raghavan, V. M.:** *Plagioclase felspars of granites, gneisses and associated rocks of Jalarpet.* **J. Madras Univ. B. 24:** 341-46, 1954.

A study of the twin-laws of plagioclase felspars from this area shows that the albite-ala law is as much characteristic of granites and gneisses as albite and pericline laws. Albite-ala is more evident in granites than in gneisses.

Madras University : Department of Statistics
Abstracts of Papers Published, 1950-53

1950

1. **Rajalakshman, D. V.:** *Studies in War-time Demography.* **Indian J. Econ., 30:** 311-333, 1950.

This paper gives a complete statistical study of vital statistics for the war period with special reference to Madras Province. Detailed analysis is given of trends in births and in mortality. A study of seasonal fluctuations has also been provided and wherever possible corresponding figures for other countries are given to provide a comprehensive picture.

2. **Suryanarayana, O.:** A *Statistical study of the Import Trade of India during* 1900-1938. **J. Madras Univ. B. 20:** 86-122, 1950.

An intensive analysis of the fluctuations in the volume of import trade of India for a period of 38 years from 1900-1938 has been undertaken. The general trends in the volume of imports of thirteen important commodities have been studied by fitting suitable curves for the volume indices. The trend eliminated fluctuations for all the commodities have been combined using weighted averages and the series so formed has been studied for periodicities, using harmonic analysis. It has been noted that seven years is a significant period for import trade of India. The appendices of the paper include exhaustive tables and graphs giving the details of the analysis.

1951

3. **Ramachandran, G.:** *On a test whether two samples are from the same population.* **J. Madras Univ. B. 21:** 124-139, 1951.

If X and Y are two independent stochastic variables whose distribution functions are given continuous, and m and n are independent observations on these two variates respectively, Wald and Wolfowitz developed a method of testing the hypothesis that these distribution functions are identical. This test U, consisting of the total number of runs, has been considered in detail in this paper and an attempt is made to improve it by utilising further information from the sample. A test criterion R has been specified, using the range of the run lengths and distribution of this criterion has been obtained. A comparative study of the two tests U and R has been provided for certain values of m and n. Tables for the test criterion R for sample sizes ranging from 2 to 12 are given in the appendix to the paper.

1952

4. **Ramachandran, G.:** *A Note on the moments of a function of 'Run Lengths.'* **J. Madras Univ. B. 22:** 92-101, 1952.

In this paper the sum of squares of lengths of all the runs obtained by arranging n_1 black and n_2 white points randomly on a straight line is used as criterion to discriminate between various run patterns. The first two moments of the distribution of the criterion when $n_1 = n_2$ are obtained and the nature of the distribution is studied.

5. **Suryanarayana O.:** *A Note on the correlogram of the generalised moving average.* **J. Madras Univ. B. 22:** 102-108, 1952.

The correlogram of the time series generated by the moving average scheme given by $V_t = \sum_{i=0}^{m} a_{i+1} X_{t+i}$ has been studied in this paper. The lag correlations of the different series are also obtained and used to verify some special cases already derived independently from these general results.

6. **Sundararajan, M. S.:** *The theory of probability distribution of points on a circle.* **J. Madras Univ. B. 22:** 109-118, 1952.

Taking a set of n points of which n_1 are black and n_2 white, such that $(n_1 - n_2) = n$, distributed evenly on the circumference of a circle, the paper deals with the first four moments of the distributions of different types of joints, triplets and quadruplets both for free and non-free sampling. Expressions are derived for central and factorial moments and cumulants. Using these results the nature of these distributions have been discussed.

7. **Suryanarayana, O.:** *Applications of the variate-difference method to analysis of two time-series.* **J. Madras Univ. B. 22:** 234-260, 1952.

In this paper different tests are obtained for determining the degree common to the polynomial trends of two time-series and they have been illustrated numerically. An extension of these tests to several time-series is also considered.

1953

8. **Ramachandran, G.** and **Ranganathan, J.:** *A non-parametric two sample test.* **J. Madras Univ. B. 23:** 76-91, 1953.

The sums of squares of the lengths of runs obtained by arranging the observations of two random samples, each of size n, in ascending order of magnitude, is discussed in this paper as a non-parametric two sample test criterion and the moments of its distribution are derived. These have been used to specify the suitable curve for the distribution and levels of significance of the fitted distribution have been computed.

9. **Rajalakshman, D. V.:** *Stochastic Processes.* **Proc. 40th Indian Sci. Congr.** Part IV 42-44, 1953.

After defining stochastic processes, a brief account of the stationary processes and their applications for the analysis of time series is given. Goodness of fit tests for these models are also discussed.

10. **Rajalakshman, D. V.:** *Statistical Problems in Econometric Models.* **Econometrica: 21: (1953).**

The choice of suitable mathematical models for representing quantitative data in social sciences is considered in this note.

11. **Bartlett, M. S.** and **Rajalakshman, D. V.:** *Goodness of fit tests for simultaneous autoregressive series.* **J. roy. statist. Soc. B. 15:** 107-124, 1953.

The asymptotic goodness of fit tests for simultaneous auto-regressive stationary series with discrete time have been derived. Besides providing the extensions of similar studies for single series, these have given rise to some interesting new features. The general solution is applied to a particular first-order process in two variables for which artificial series are available for test. The extension of these tests to series with correlated residuals and hence to continuous simultaneous autoregressive series has been discussed.

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